ENGINEERING AND MINING JOURNAL

A McGRAW-HILL PUBLICATION

JULY 1957

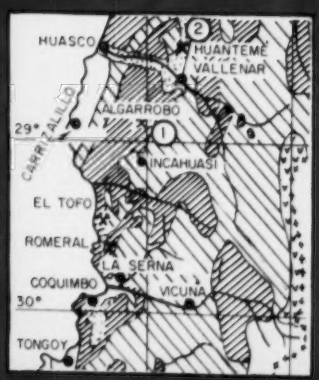
PRICE ONE DOLLAR

FOUNDED 1866

Safety saturation at Kennecott's Ray mines is paying off in fewer lost-time accidents, lower injury rates and better morale. p 80

Choosing mill liners of moly-chrome is easy if you know the various types and their properties. p 102

Chile — A new Latin American area for iron ore exploration. An expert sets up the guideposts. p 90



Integrated haulage engineering cut costs, boosted safety at TCI p 84

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No packing

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No mechanical seal

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No liquid seal

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No exposed metal parts

Having no stuffing box, the A-S-H Packless pump avoids wasteful leakage of valuable solution. Using no liquid seal, it delivers the solution *undiluted.* And, corrosive, abrasive solutions never come in contact with metal, for the positive-feed tank, pump shell, impeller and extended-drive shaft are protected by easily-replaced Maximix rubber or Neoprene.

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PACKLESS RUBBER-LINED PUMPS

A-S-H Flex-Check rubber-lined valves are often used with the Packless pump. Though bottle-tight against back pressure, they offer negligible resistance to the flow.

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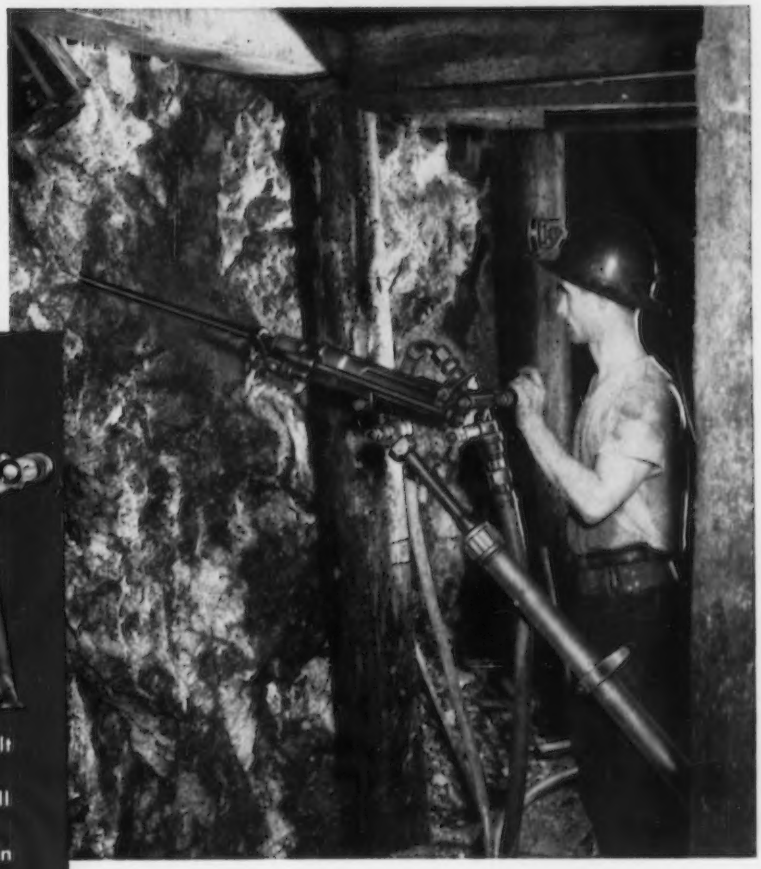
Here's why the JR-38B

UNIVERSAL JACKDRILL

gives you MAXIMUM FOOTAGE PER SHIFT at LOWEST OVERALL COST



FEATURES

- Roll-Type Feed-Leg Valve built into handle
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- Built-in Air Connection between drill and leg
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- Constant Chuck Blowing
- One-Piece Chuck with renewable bushing
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Set-up time can be converted to drilling time with the Ingersoll-Rand JR-38B Jackdrill — the easiest-handling one-man universal drilling unit ever developed. Designed to take full advantage of the inherent economies of 1⅜" Carset Jackbits, it saves drilling time, too, and reduces air requirements as well. The JR-38B is rugged — it stays on the job. These savings add up to maximum footage per shift and a new low in drilling costs.

The features at the left give some of the reasons for this outstanding Jackdrill performance. For the complete story, see your I-R man or send for a copy of Bulletin 4144A.

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ENGINEERING AND MINING JOURNAL

91st YEAR OF PUBLICATION

JULY 1957

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B.F.Goodrich report:

Men with hose are changing the shape of the earth

B. F. Goodrich improvements in rubber brought extra savings

Problem: Those workmen are drilling holes for dynamite charges that will blast solid rock to pieces. They're at work on the St. Lawrence Seaway, where the shape of the earth is being changed, so that ocean-going ships can reach the Great Lakes.

The air hose on such jobs used to go to pieces, too. When heat from the compressor got into the hose, it would harden the rubber, breaking it into loose pieces that clogged the air tool, put it out of action.

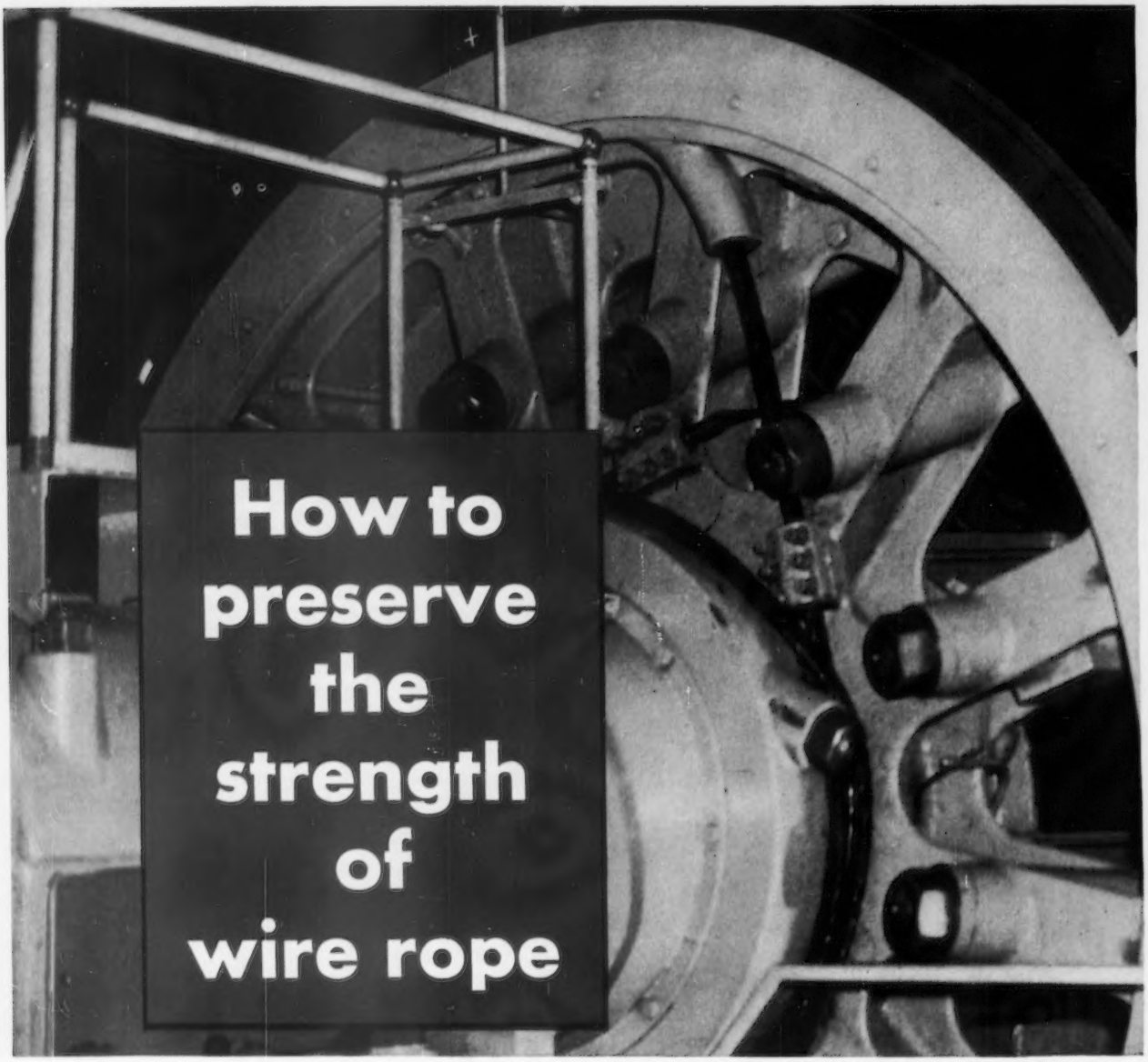
What was done: B.F.Goodrich engineers went to work on the problem. By adding, subtracting, changing proportions of rubber, they developed a special compound for the hose that stands heat without scorching or hardening. Hose lined with this new rubber was made and put to work.

Savings: On jobs where air hose used to go to pieces in weeks, B.F.Goodrich hose lasts months, even years. Thousands of feet of it are in constant use on the Seaway project, doing dozens of different jobs. The hose pictured above has been at work 6 months, is expected to last another year despite the rough treatment it gets. It is dragged over rough rocks and is often run over by trucks.

Where to buy: Your B.F.Goodrich distributor has exact specifications for the B.F.Goodrich air hose described here. And, as a factory-trained specialist in rubber products, he *can* answer your questions about *all* the rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-993, Akron 18, Ohio.*

B.F.Goodrich

INDUSTRIAL PRODUCTS



You can keep wire rope strong longer by using a lubricant that protects every strand—and surrounds and preserves the core.

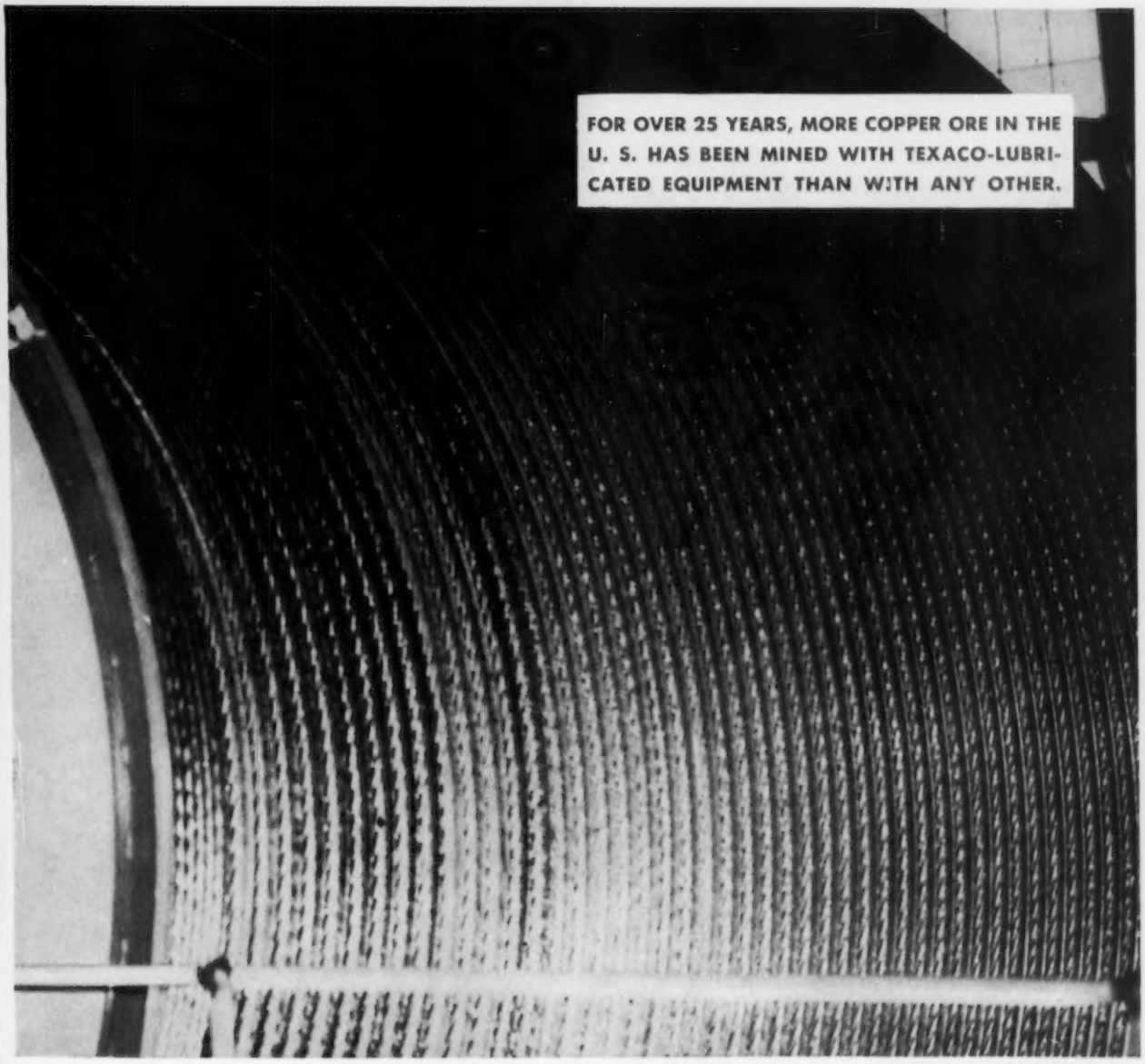
Use *Texaco Crater*. It does both of these jobs effectively. It penetrates the rope—encloses and seals the core. Its protective film prevents both rust and corrosion—minimizes wear by reducing both internal and external friction. In addition, it is sufficiently adhesive to cling to the strands and provide long-lasting protection.

You can use *Texaco Crater* on hoist lines, power shovels, draglines and slusher ropes. You'll find it's economical protection—especially so when you compare the low cost of lubrication to the high cost of downtime and replacement.

Texaco Crater is ideal, too, for open gears.

TEXACO

TEXACO



It stays on the teeth—protects gears against wear by cushioning shocks and heavy loads.

Texaco Crater X Fluid offers you the application ease of a spray-on lubricant for both gears and wire rope. It has all the protective properties of regular *Crater*.

For mine car wheels, use *Texaco Olympian Grease*. It stays in the bearings—insures easy starts at any temperature and protection against wear, dirt and moisture.

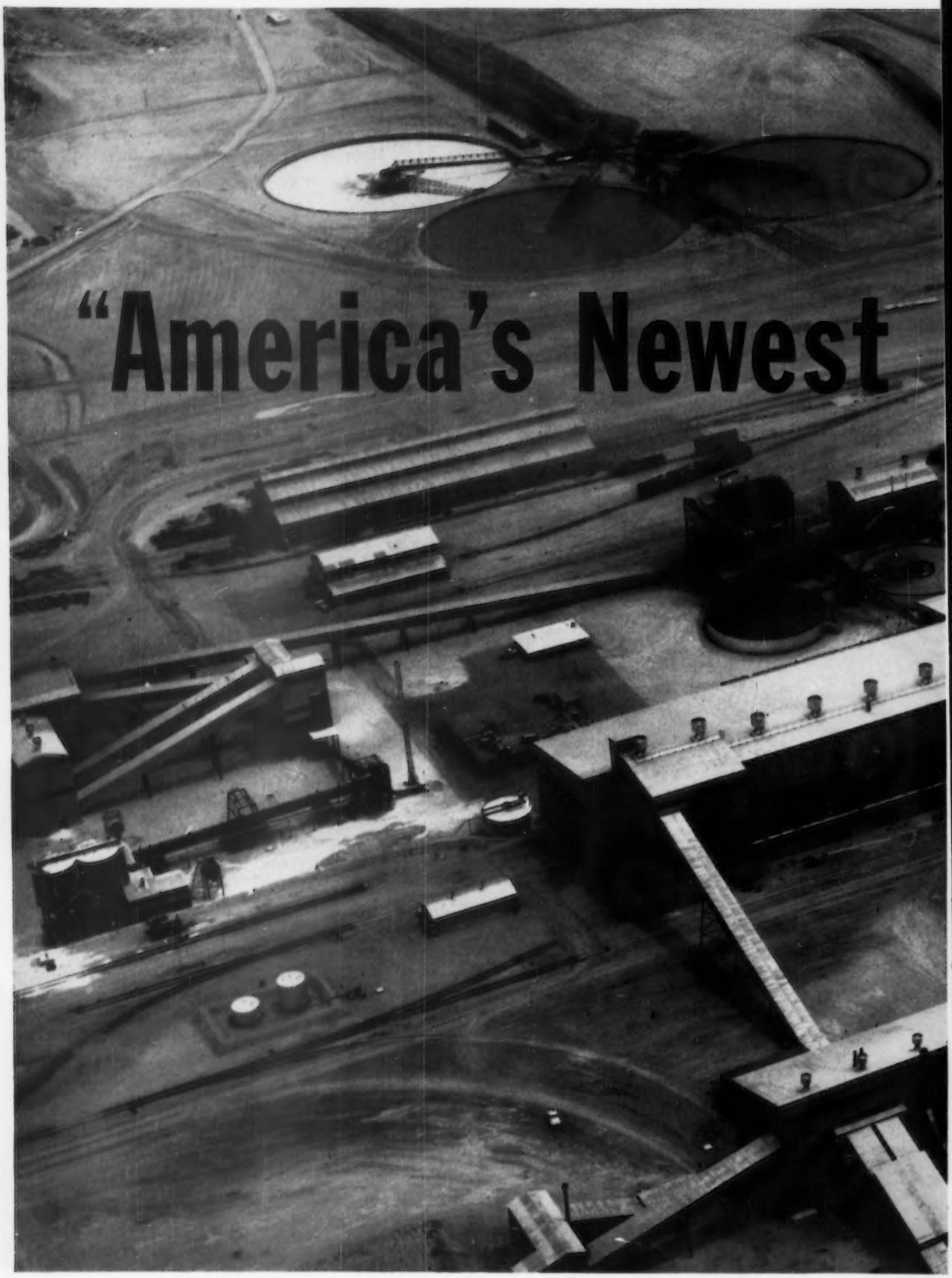
A Texaco Lubrication Engineer can help you cut maintenance costs with an efficient lubrication program. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

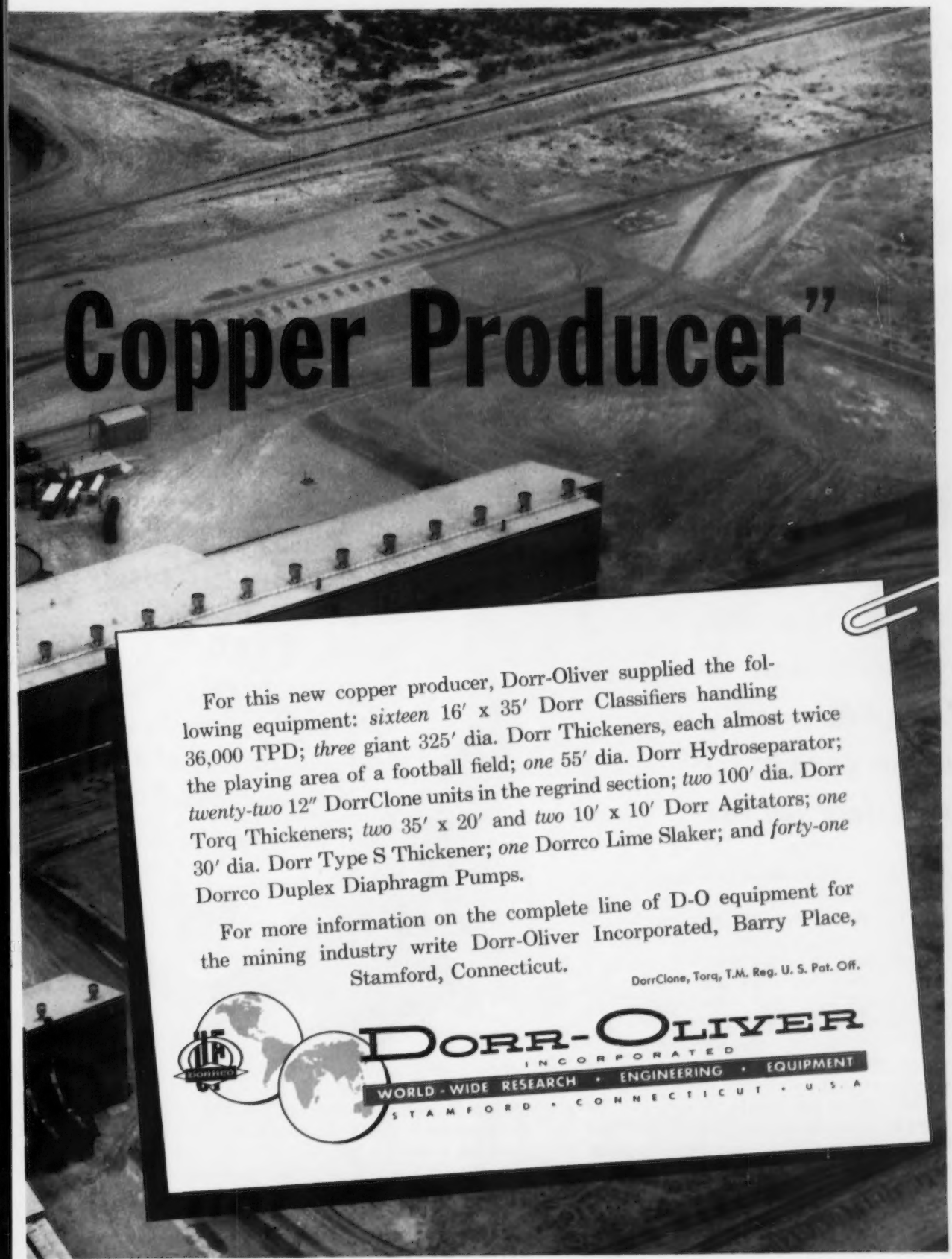
☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

Lubricants and Fuels

FOR THE MINING INDUSTRY


"America's Newest



For this new copper producer, Dorr-Oliver supplied the following equipment: *sixteen* 16′ x 35′ Dorr Classifiers handling 36,000 TPD; *three* giant 325′ dia. Dorr Thickeners, each almost twice the playing area of a football field; *one* 55′ dia. Dorr Hydroseparator; *twenty-two* 12″ DorrClone units in the regrind section; *two* 100′ dia. Dorr Torq Thickeners; *two* 35′ x 20′ and *two* 10′ x 10′ Dorr Agitators; *one* 30′ dia. Dorr Type S Thickener; *one* Dorrco Lime Slaker; and *forty-one* Dorrco Duplex Diaphragm Pumps.

For more information on the complete line of D-O equipment for the mining industry write Dorr-Oliver Incorporated, Barry Place, Stamford, Connecticut.

DorrClone, Torq, T.M. Reg. U. S. Pat. Off.

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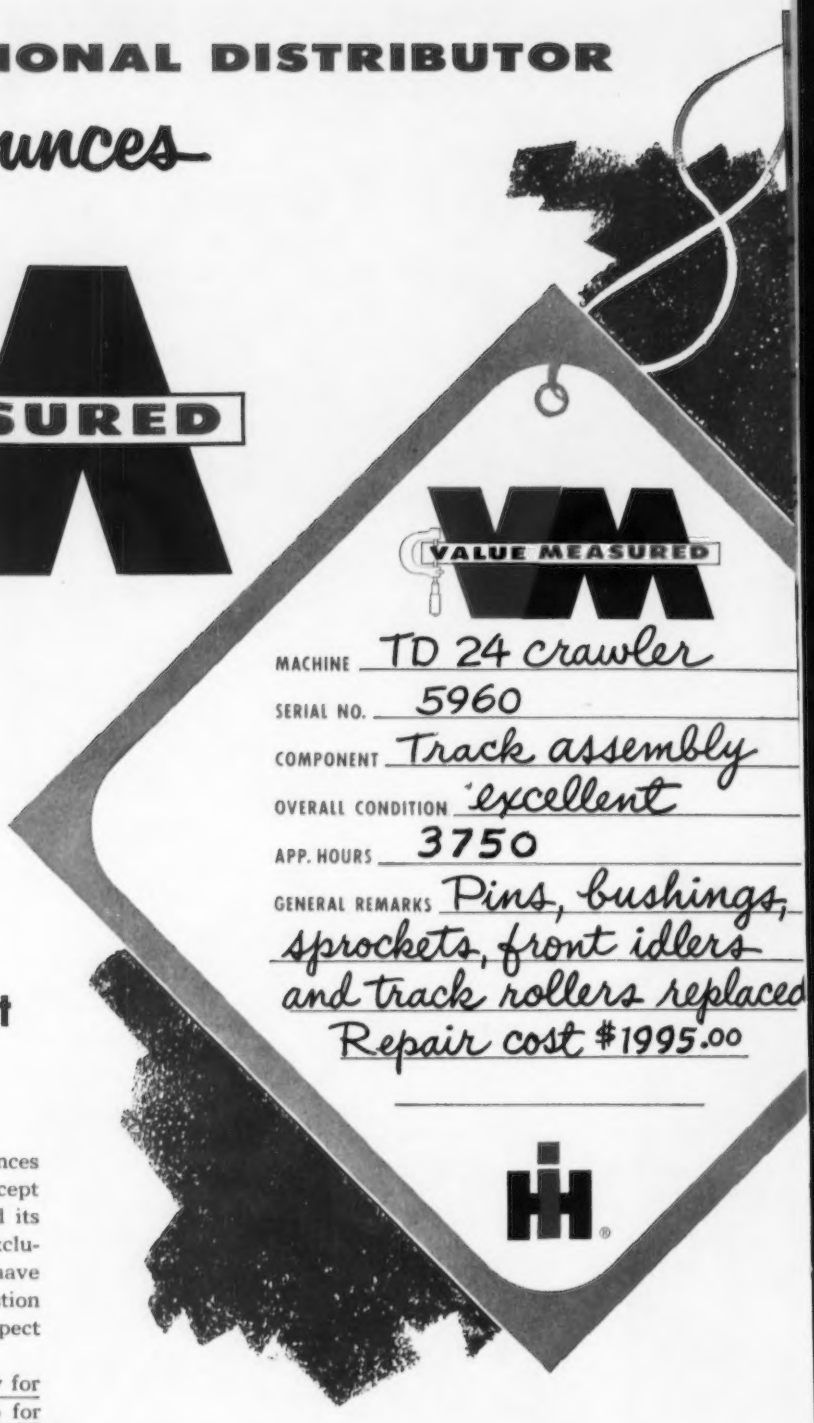
VALUE MEASURED
MACHINE TD 24 crawler
SERIAL NO. 5960
COMPONENT Track assembly
OVERALL CONDITION excellent
APP. HOURS 3750
GENERAL REMARKS Pins, bushings, sprockets, front idlers and track rollers replaced
Repair cost $1995.00

The exclusive equipment buying plan that **V**alue **M**easures used machinery and its component parts before you buy!

Your International Distributor proudly announces VM...a revolutionary equipment buying concept that measures the value of used machinery and its components before you buy! Now, under this exclusive International Distributor program, you can have a reasonable answer to your most important question when buying used equipment..."What can I expect of this machine and for how long?"

The answer is supplied in two ways, not only for the over-all condition of the machine but also for all the major parts of the machine as well! And the answers are easy to get. They're all tabulated for you on big tags, (see illustration, above), which are attached to the component or near it. Each tag names the component, gives you the over-all condition of it, tells the approximate hours of operation (because parts are changed in units at different times), and shows whether the item has been repaired or replaced with a new part. The tags permit you to examine a piece of used machinery quickly, completely, and with confidence. In fact, VM – the IH Value-Measured Used Equipment Plan–does for you what you yourself would like to do to check used equipment, if you had the time and facilities.

Your International Construction Equipment Distributor has Value-Measured Used Equipment buys on his lot, now. Be sure to see him soon and find out why VM is your best way to buy used construction machinery.

Clean-up! A Value-Measured Used Equipment buy first gets a steam bath before inspection of major parts. Clean machine reveals wear, cracks, other damages which need repair.

Check up! Dynamometer engine testing is typical of thorough inspection and testing before and after worn engine parts are replaced. Testing equipment of this type enables distributor to guarantee performance on VM equipment.

Fix up! After testing, distributor servicemen make necessary repairs and adjustments to equipment. All such repairs and their cost are tabulated on VM tags which you'll find conveniently attached to the components.

Measure up! You'll find the VM buy headquarters sign only at your International Construction Equipment Distributor. Stop here soon if you need used construction equipment...and become acquainted with the industry's newest, safest, and most economical way to buy used machinery...the VM way.

VM Purchase Certificate is your guarantee that every major working area of the used machine has been thoroughly checked and repaired, or replaced, when necessary. It also means your VM used machine is the best buy for the price.

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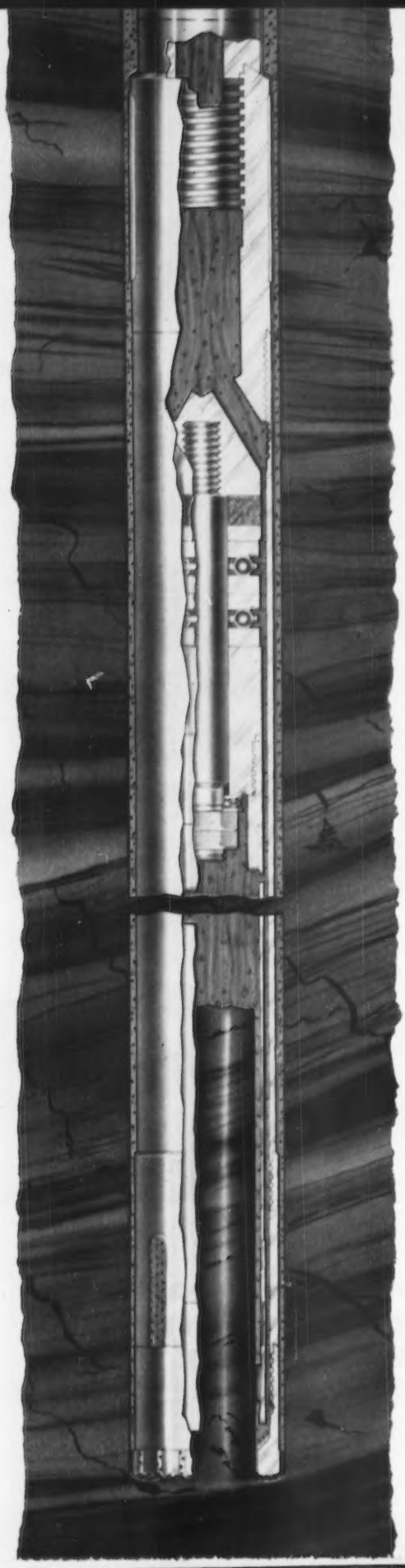
International Harvester Co., 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors... Self-Propelled Scrapers... Crawler and Rubber-Tired Loaders... Off-Highway Haulers... Diesel and Carbureted Engines... Motor Trucks... Farm Tractors and Equipment.



3 things make the Longyear "L" Series Barrel better than any other

Drillers using Longyear "L" Series Core Barrels *report better recovery in ground that is hard to core.* In one broken, unconsolidated ore zone, the "L" Series Barrel increased recovery from 40 to 89%, compared to results with another type of barrel. Some 15,800 feet were drilled with the "L" Series Barrels in this formation. Three things make the "L" Series Core Barrels better by drillers' standards:

1. With most other core barrels, slight wear and heavy downward pressure can cause belling at the joints. When this happens, the tools stick tight in the hole. *Bevel shoulders on "L" Series Core Barrels, bits and shells eliminate belling by greatly strengthening joints in the lower end.*

2. "L" Series Core Barrels have a slip fit between the core lifter case and inner tube instead of the usual threaded connection. No special tools are needed to separate them, so there is less chance of distortion. Consequently these vital parts *work the way they should longer.*

3. The Longyear Water Shut-off Valve eliminates errors in detecting a block. In closed circuit drilling (possible with Longyear Transmission Pumps), the driller gets a positive indication when a block occurs, and stops drilling before grinding of core starts. Thus, the Shut-off Valve improves core recovery and holds down bit costs, which soar when grinding takes place.

The Longyear representative in your area can tell you more about the advantage of the "L" series and other fine Longyear Core Barrels.

E. J. Longyear Company, **MINNEAPOLIS 2, MINN.**

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LONGYEAR N. V., THE HAGUE, HOLLAND

Diamond Core Drill Manufacturers • Core Drilling Contractors
Mining Engineering and Geological Consultants

18 EARTH-MOVERS MOVE 1,400,000 YARDS IN 90 DAYS—

CUT SCHEDULED TIME IN HALF!

▲ One of "the earth-movin'est earth-movers around," Holloway Construction Co., Livonia, Mich., proved it again when grading for relocation of U. S. 16 at Brighton, Mich. Work started 12 days after job was let—and 6 miles of sand, clay and muck up to 40 feet deep were hustled as never before. Tires shown are Goodyear TUBELESS Sure-Grip Lug—built with triple-tempered TRIPLE-TOUGH 3-T NYLON Cord.

▲ GOODYEAR BIG TIRE SERVICE at Holloway's U. S. 23 relocation job at Fenton, Mich. Strategically located, well-equipped, well-manned service like this cuts down time to a minimum wherever Goodyear helps jobs roll. Tire shown is Goodyear TUBELESS again!

80% CUT in earth-mover tire down time!

That just ***begins*** *your savings with 3-T Nylon Cord*

TUBELESS TIRES!

ON JOB AFTER JOB, contractors agree that tube and flap troubles cause up to 80% of tire down time. End tubes and flaps and those troubles end, too—and you also save on tube replacement and inventories.

You save time mounting—you save extra valve parts—you save on maintenance, for with Goodyear TUBELESS many repairs may be made *without removing tires!*

YOU SAVE TIRES, TOO—for with Goodyear TUBELESS, small injuries usually show *before* they get serious.

So be sure you specify Goodyear 3-T Nylon Cord TUBELESS tires on all new equipment—and see your Goodyear dealer for change-over of present vehicles. Goodyear, Truck Tire Dept., Akron 16, Ohio.

NOW TUBELESS OR TUBE-TYPE WITH 3-T NYLON CORD!

Look for this nearby Goodyear dealer sign for better tire values—better tire care.

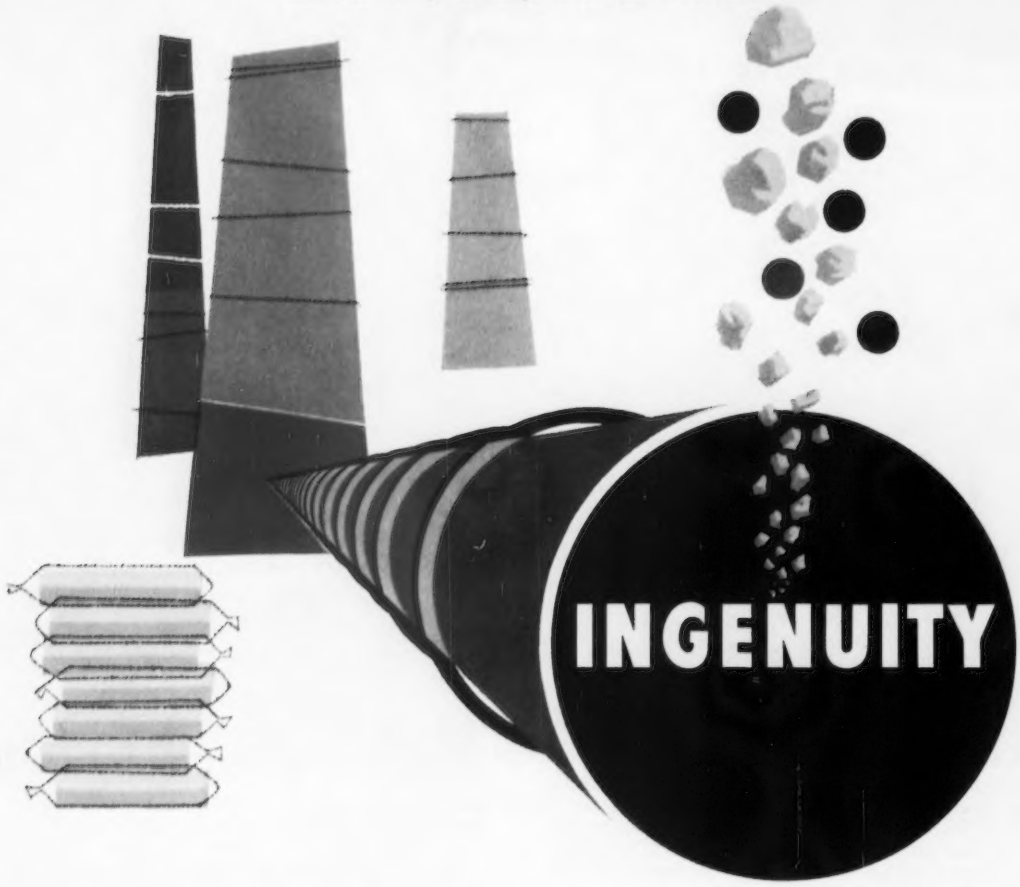
Buy and Specify

GOODYEAR

MORE TONS ARE HAULED ON GOODYEAR TRUCK TIRES THAN ON ANY OTHER KIND

All-Weather, Road Lug, Sure-Grip—T.M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

call KE for plant expansion or new facilities



1,250,000 barrel cement plant addition recently completed by KE for Marquette Cement, one of world's largest cement producers.

has made KE a major engineer-contractor serving the Minerals Industry

Placing of four fully-lined mills in a few hours instead of days—a unique center pier kiln drive —a 2,700′ cement transport "airway." With these and many more planned innovations and short-cuts, Kaiser Engineers completed Marquette Cement's Cape Girardeau plant expansion quickly and economically. Construction cost and time were well below industry average.

Mining, transportation, beneficiation, materials handling, processing in cement, gypsum, coal, ferrous and non-ferrous metals facilities—these are but a few of the fields wherein KE serves the Minerals Industries—from economic analysis through start-up.

KE ingenuity—multi-industry experience, keenly applied—can benefit your next facility. Let us show you how.

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Contracting since 1914

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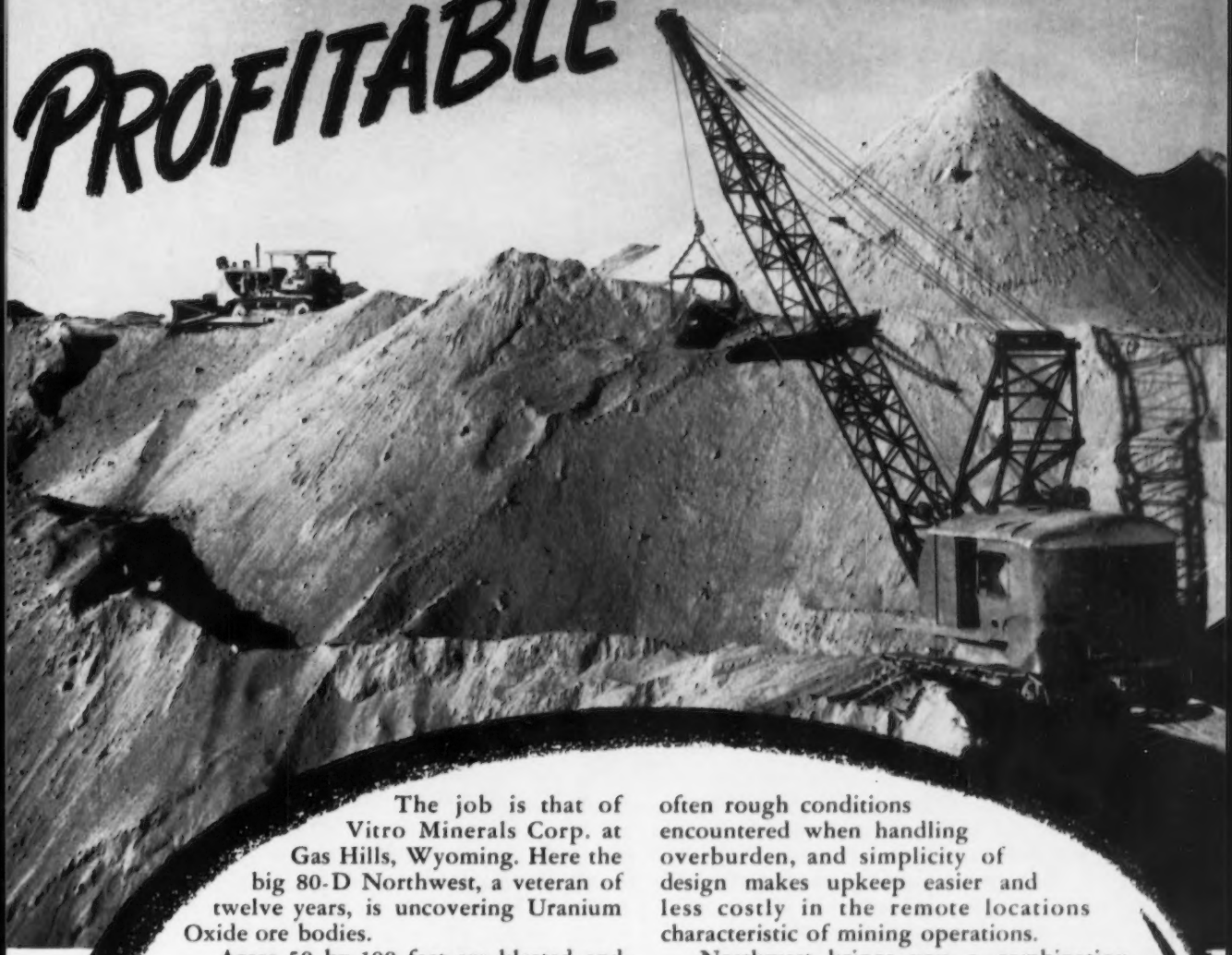
MAKING MOVING OVERBURDEN PROFITABLE



The job is that of Vitro Minerals Corp. at Gas Hills, Wyoming. Here the big 80-D Northwest, a veteran of twelve years, is uncovering Uranium Oxide ore bodies.

Areas 50 by 100 feet are blasted and uncovered. The amount of overburden removed is enormous, but it has been found that 20 feet of overburden can be profitably removed for every foot of ore.

Fast operation, the smooth control that comes with Northwest Uniform Pressure Swing Clutches and the "Feather-Touch" Clutch Control means more bucket loads dumped per hour, and under many conditions more output than larger rigs. Positive traction on both crawlers while turning as well as when going straight ahead assures easier travel in the often rough conditions encountered when handling overburden, and simplicity of design makes upkeep easier and less costly in the remote locations characteristic of mining operations.

Northwest brings you a combination of advantages found in no other similar equipment—the "Feather-Touch" Clutch Control for easy operation, Northwest Simplicity of Design for easier upkeep, Uniform Pressure Swing Clutches, Northwest Steering, Cast Steel Machinery Side Frames, the Cushion Clutch, the Northwest Dual Independent Crowd—all combine for greater output at lower cost. You can't have too much Northwest performance. Why not talk it over with a Northwest man and let him tell you how?

THE GREATEST COMBINATION OF PROVED ADVANTAGES EVER BUILT INTO A SHOVEL, CRANE, DRAGLINE OR PULLSHOVEL

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Convertible for any Mining Material Handling or Excavation Problem

580-35 LG

"Sunday-Punch"

The pin-point blasting that rips away the side of a hill for strip mining is just one of the many mining operations in which Simplex products play an important part. Simplex-TIREX trailing cords and cables, engineered especially for mining work, are on the job in and around mines everywhere. TIREX cables are newly improved for greater flexibility. Their cured-in-lead Neoprene Armor resists abrasion, oil, heat and water, and gives longest life.

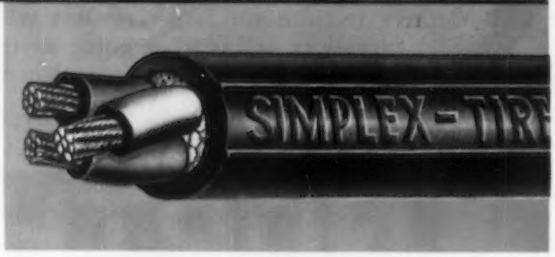
SIMPLEX WIRE & CABLE CO.,
79 Sidney Street, Cambridge 39, Massachusetts.

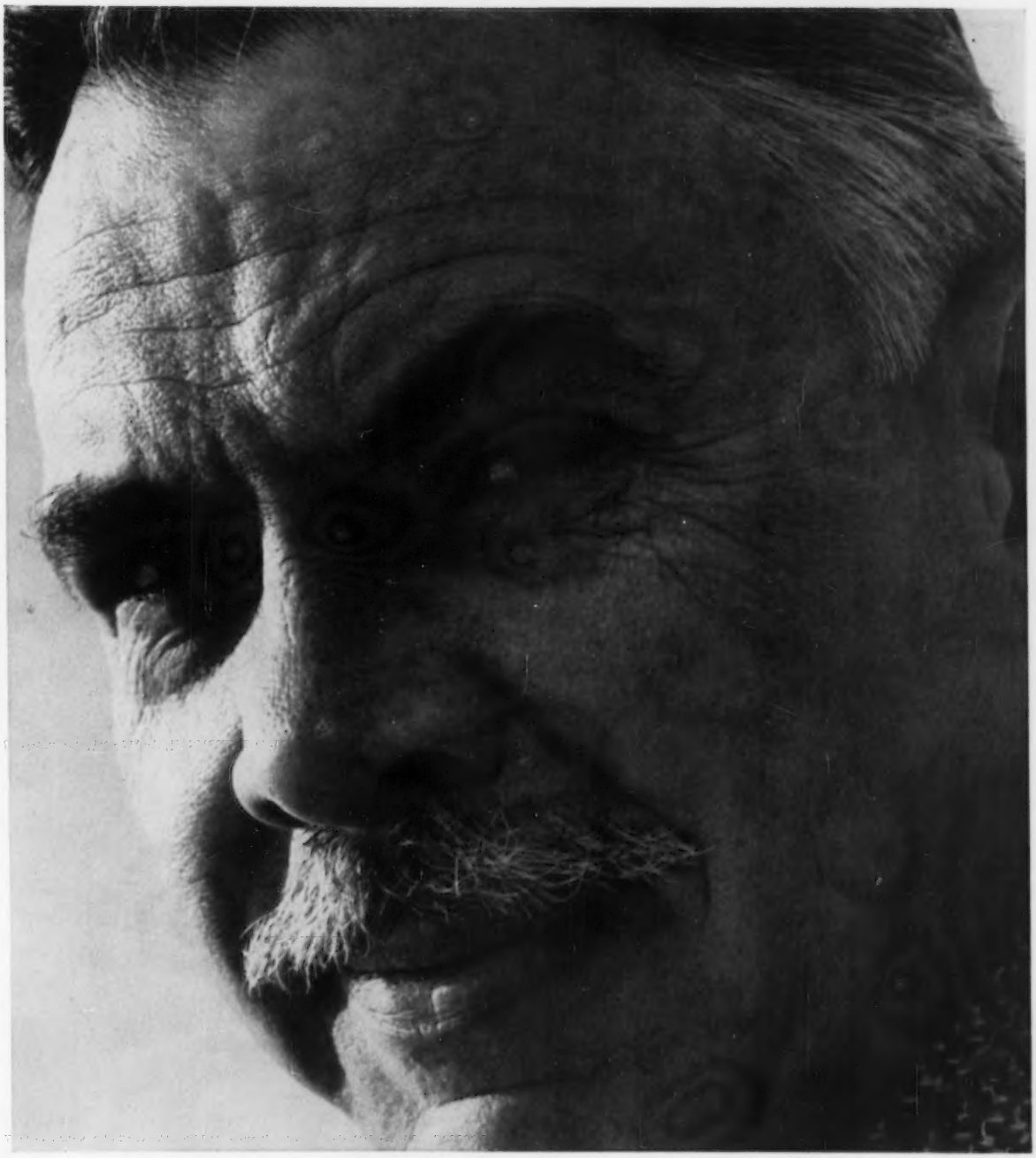
Wire sculpture by Henry Strafer

LIVE BETTER ELECTRICALLY

Simplex

TIREX



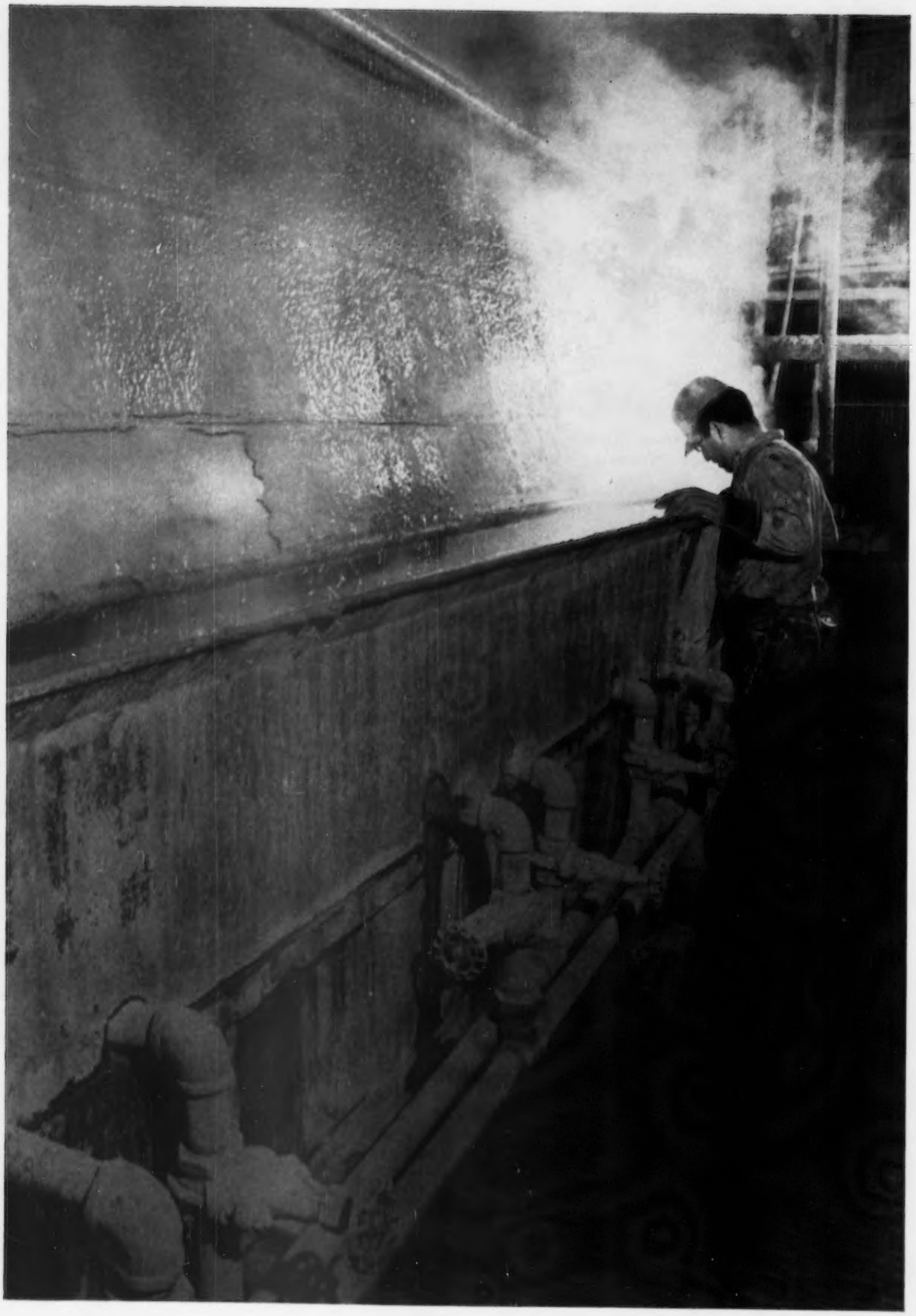


When your process calls for chemicals talk to the man from Dow

YOU CAN DEPEND ON DOW FOR: XANTHATES • DOWFROTH® 250 • Z®-200 • SEPARAN 2610® • HYDROCHLORIC ACID • AMMONIA • CHLORINE CAUSTIC SODA • VERSENE® • MAGNESIUM OXIDE • MAGNESIUM HYDROXIDE • ION EXCHANGE RESINS • SOLVENT EXTRACTANTS

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

DOW



New Mexico: close-up of uranium filtering operation at Blue Water Plant of The Anaconda Company.

On these filters Separan 2610 more than doubled mill throughput

Another production problem solved with the new high-speed flocculant, Separan 2610

Previous to using Separan 2610® as a flocculant, this southwestern uranium processor undertook what seemed to be an impossible task. He wanted to double tonnage throughput without adding filtering or thickening equipment.

This processor tried the "old stand-by" flocculants, but could get neither the desired flocculation speed nor thick enough filter cakes that would discharge easily. To accomplish his goal seemed impossible . . . until he talked to the man from Dow and applied the new and different flocculant, Separan 2610.

Here are the results:

Ore	Before Tons/Day	After Tons/Day
Very slimy	50	400...at 1.0# Separan/T
Blended	200	450...at 0.6# Separan/T
Blended	250	500...at 0.5# Separan/T
Good limestone	350	500...at 0.15# Separan/T

You'll notice that with Separan 2610, average filtering rate of the various ore compositions *more than doubled!* This is no phenomenon. Separan 2610 has proved itself with practically every mineral mined. In several mills, it has even tripled production rates!

Easy to prepare and apply

Being a synthetic organic polymer, every order of Separan 2610 provides the same uniform quality. It adds no excess bulk, is effective in both acid and alkaline circuits. Stock solution requires no heat or preservative; a disperser enables you to prepare large amounts without a mechanical mixer.

For faster settling, improved filtration, reduced loss in overflow—try this revolutionary flocculant yourself. Available from three f.o.b. points: Midland, Michigan; Pittsburg, California; and Velasco, Texas . . . and from two stock points: Port Newark, New Jersey, and St. Louis, Missouri. Samples, technical assistance and results more specifically related to your type ore can be obtained through your Dow man. Or write us direct. THE DOW CHEMICAL COMPANY, TECHNICAL SERVICE AND DEVELOPMENT, Midland, Michigan, Dept. SE 1316A.

When your process calls for chemicals, talk to the man from Dow

XANTHATES • DOWFROTH® 250 • Z®-200 • SEPARAN 2610® • HYDROCHLORIC ACID
AMMONIA • CHLORINE • CAUSTIC SODA • VERSENE® • MAGNESIUM OXIDE
MAGNESIUM HYDROXIDE • ION EXCHANGE RESINS AND SOLVENT EXTRACTANTS

YOU CAN DEPEND ON DOW

Dirt, Corrosion, Low Voltage Problems?

the answer:

Allis-Chalmers "dc operated" ac contactors*

Allis-Chalmers Size 6 starter, NEMA 1 enclosure.

Dc operators in Allis-Chalmers control assure dependable performance because they are not affected by dirt or corrosion on the armature face. Positive magnetic operation reduces contact pitting — eliminates hum and chatter—prolongs mechanical life. The operator picks up at 65% of rated voltage — holds in with as little as 35%.

For Any Low Voltage, High Horsepower Application . . . Allis-Chalmers Modern Control — Sizes 4, 5 and 6

Advanced Electrical Design

ACBO arc-centering blowout sharply curtails arcing time, greatly prolongs contact and chute life — without blowout coils.

Simplified Mechanical Design

Streamlined clapper-type construction permits natural arc rise in arc chute. Sensible enclosure dimensions provide ample wiring space. Easy accessibility simplifies maintenance.

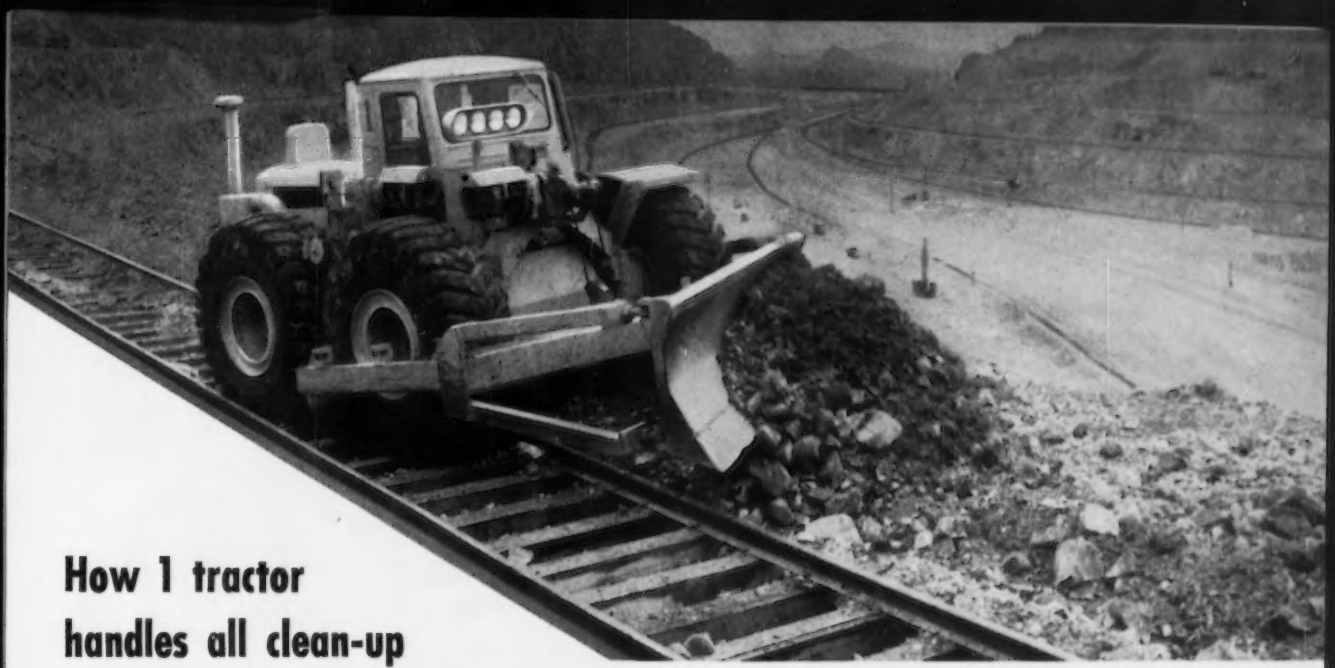
For detailed information on this complete line of modern control, call your A-C Control Distributor or A-C District Office. Or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

*Self-contained ac to dc circuit. Standard in Size 6, optional in sizes 4 and 5.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS A5372

ACBO is an Allis-Chalmers trademark.



How 1 tractor handles all clean-up around fleet of scattered shovels

At this large open-pit copper mine in Arizona, copper is produced from huge tonnages of rock and ore that are mined each day. Equipped with Angledozer and tilt mechanism, 210 hp Tournatractor makes quick work of clearing shovel-spillage from railroad tracks.

A large open-pit copper mine in Arizona uses only one tractor for all clean-up around their widely scattered production shovels. It is the 210 hp rubber-tired LeTourneau-Westinghouse Tournatractor®. Here's how this 17 mph tractor operates during a typical 8 hour day:

Averages 10 min. per shovel

When the 6-yd. shovels have completed loading a string of ten to twelve 84-ton capacity rail-cars, Tournatractor drives in and goes to work. Straddling the rails, this rubber-tired tractor efficiently dozes shovel spillage off tracks with its Angledozer* blade. At each shovel, speedy Tournatractor cleans-up loading area and railroad track in about 10 minutes!

Takes shortest route to next location

When each assignment is finished, Tournatractor operator just flips instant-shift lever and he's on his way to the next shovel. There are no delays for crawling or load-and-haul to new location. A mile is only a couple minutes away! Tournatractor always takes the shortest, fastest route to the next work location . . . often "runs" down steep "shot" banks to lower benches. Big, low-pressure tires do not damage air-drill hose lines, RR tracks, ties, switches, or haul road surfacing.

"You can't beat Tournatractor"

Handling all clean-up work for the shovels . . . plus completing numerous scattered maintenance jobs during his 8 hour shift . . . Tournatractor operator said, "You can't beat this tractor for clean-up work. This is the place for rubber . . . I can move around faster than a pick-up truck on some of our benches."

For more information

If you use several crawler-tractors for clean-up at your pit, plant, and stockpiles, investigate how Tournatractor's power . . . traction . . . speed . . . and "go-anywhere" mobility can pay off for you. We'll be glad to demonstrate Tournatractor at your pit . . . let you judge for yourself.

*Trademark CT-1482-M-1

Go-anywhere Tournatractor "runs" down a "shot" bank to shorten travel time between shovels. With big, multi-disc air brakes — totaling 3,762 sq. in. of brake surface — operator has sure, safe control at all times.

Crossing tracks, Tournatractor's big, low-pressure tires deflect to prevent damage. They do not loosen rails, damage ties or switches.

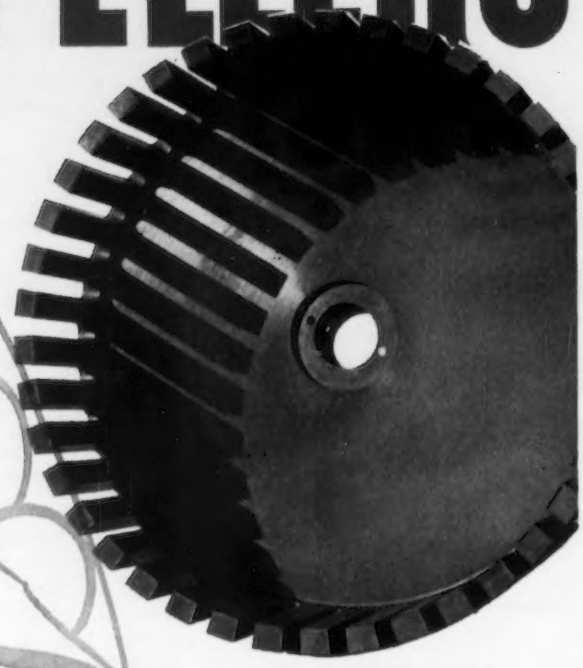
LeTourneau-WESTINGHOUSE Company, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

WHERE QUALITY IS A HABIT

As like as peas in a pod!

Pressure-Molded (RUBBER COVERED) IMPELLERS



Pressure molding of the rubber covering of the metal core of the AGITAIR® impeller results not only in an amazing uniformity and perfect bond but also speeds up production to meet the rising world demand for this rugged flotation machine.

Another unique feature of the AGITAIR® is that aeration is not dependent on impeller speed because of the utilization of a constant external air supply. This allows lower impeller speeds with resultant longer life of operating parts without jeopardizing metallurgical efficiency.

AGITAIR® FLOTATION MACHINE

The marked improvement in the impeller-heart of AGITAIR®— results in a greater uniformity of operation.

Keep your metallurgy up to date by installing AGITAIR®— the machine that is progressively improved by laboratory experiment and mill experience. Write for details.

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THE GALIGHER CO.

METALLURGICAL DIVISION · ENGINEERING SERVICE

A-514

CONSULTATION • ORE TESTING • PLANT DESIGN

GALIGHER PRODUCTS: AGITAIR® Flotation Machine, VACSEAL Pump, Geary-Jennings Sampler, Acid-proof Sump Pump, Geary Reagent Feeder, Laboratory AGITAIR® Flotation Machine, Laboratory Pressure Filter, Laboratory Ball Mill, Rubber Lined and Covered Products, Plastic Fabrication.

Major copper mine in Arizona

helps boost production with 2 heavy-duty graders

Building railroad bed, Adams 660 works dumped waste material to edge of bank for casting overside with bulldozer blade.

Said one grader operator, "The Adams is much faster . . . will do twice as much work. Controls are easier, blade visibility better."

At a large open-pit mine in Arizona, ore is mined at low levels and hauled by railroad cars . . . at higher levels, overburden is removed by a fleet of 35-ton trucks. To help these haulers travel at safe, profitable speeds, and to speed road and rail-spur construction — the mine uses two 150 hp Adams* 660 graders.

Patrols roads 24 hrs. a day, 6 days per week

One of the heavy-duty "660" LeTourneau-Westinghouse units is used primarily for maintaining many miles of haul roads. This fast-moving grader patrols these busy mine roads 24 hours a day, 6 days a week. It goes wherever needed . . . to fill ruts, level washboard, clear debris dropped by overloaded haulers and improve drainage.

For working along steep drop-offs, the Adams' standard blade extends a full 7½ ft. beyond wheel line, to give operator safe working margin. Extra-safe dual-braking system stops transmission as well as tandem drive-wheels for sure, safe stops and minimum brake wear.

Helps build new roads, RR grades

The second "660" grader — equipped with bulldozer blade — is used on new construction work and for maintaining waste dump. When constructing new roads or railroad beds, the "660" handles all the blade work.

Works any kind of material

Wide range of speeds give Adams advantage for working efficiently in any kind of material. All 80 to 150 hp Adams graders have an 8 forward and 4 reverse speed transmission. In addition, optional 3-speed "creeper" gears (0.23 to 1.82 mph) may be added. These low, full-power speeds move heavier loads, handle rocky material with greater speed and safety, insure more accurate blade control for fine finishing around forms or obstructions.

Adams' largest grader — the powerful 190 hp POWER-*Flow* 660, with torque converter — gives you an infinite number of speeds forward to 27.4 mph . . . reverse to 24.4 mph. Adams' smallest, the 60 hp "220", has 5 speeds forward to 18.3 mph — best in its class.

See Adams in action

Why not see how you, too, can step up mine and quarry production, cut operating costs — with heavy-duty Adams graders? There are 6 models: 190, 150, 123, 115, 80, 60 hp. Choice of GM or Cummins engines on 5 larger models. Call or write for a demonstration at your pit.

With dozer blade, "660" maintains waste dump. Over 72% of the total amount of material mined at this copper mine is waste.

Powerful "660" helps build exploration roads and RR road beds fast and easy. Commenting on the Adams grader, the second operator said, "I like the power and weight of the '660'. Also, the big 14-ft. moldboard and wide choice of speeds."

*Trademark G-1483-M-1

LeTourneau-WESTINGHOUSE Company, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

Ski lift operators stress safety when it comes to buying wire rope. Too many lives are at stake. So they buy . . .

A Safe Lift

Even though you don't operate a ski lift, false economy can be costly in your rope purchases, too. For a rope failure can cause personal injury . . . wreck your equipment . . . throw off your entire work schedule . . . and affect employee morale. Yes, a "bargain" wire rope may save you money, yet cost you your peace of mind. Don't take a chance. Buy a rope that's a quality rope—buy Wickwire Rope.

CF&I

WICKWIRE ROPE
A CF&I PRODUCT

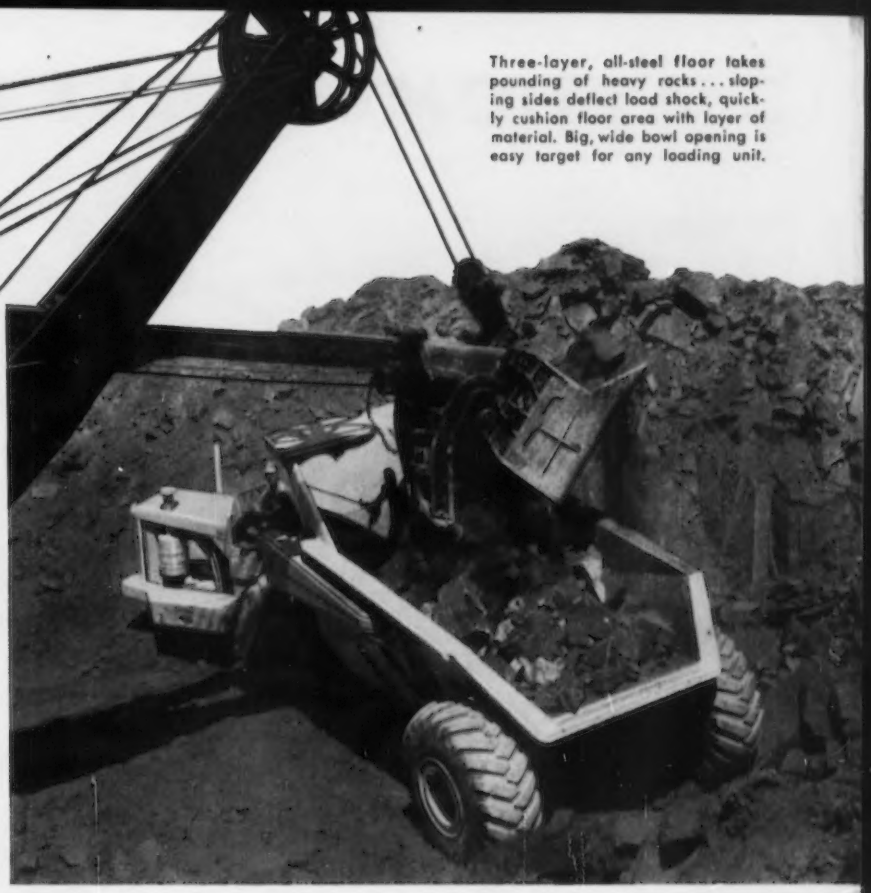
LOOK FOR THE YELLOW TRIANGLE

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

5050

THE COLORADO FUEL AND IRON CORPORATION — Denver • Houston • Odessa (Tex.) • Phoenix • Salt Lake City • Tulsa
PACIFIC COAST DIVISION—Los Angeles • Oakland • Portland • San Francisco • Seattle • Spokane
WICKWIRE SPENCER STEEL DIVISION — Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New Orleans
New York • Philadelphia

How to cut your hauling costs...



Three-layer, all-steel floor takes pounding of heavy rocks . . . sloping sides deflect load shock, quickly cushion floor area with layer of material. Big, wide bowl opening is easy target for any loading unit.

Your excavating and mining profits depend upon a *fast, continuous* hauling operation, all year long. Around the world, in all kinds of weather — modern LeTourneau-Westinghouse Rear-Dumps have been job-proven as high-production haulers. These high-speed units are extremely maneuverable. They haul anywhere, load and dump fast, cut weather delays, and insure future earnings. Here are the facts that back these important claims:

Hauls anywhere

With rubber-tired speeds, Tournapull® Rear-Dumps travel safely over paved highways, city streets, cross-country . . . through muck, rock, and soft fill. Tournapull's ability to work through soft and slippery footing is due largely to these four L-W Rear-Dump features:

1. Power-transfer differential . . . automatically transfers up to 4 times the power from slipping wheel to wheel on firmest footing.

2. Geared kingpin electric power steer . . . permits operator to pivot prime-mover — up to 90° left or right — to "walk" drive wheels onto solid footing.

3. Big, single low-pressure tires . . . provide traction and flotation . . . stay on top of the ground, instead of digging in.

4. "Humping", by varying wheel base . . . alternately pulls and pushes hauler out of ditch or mud hole. Operator sets front-wheel brakes and raises body with electric motor, pulling rear wheels forward. Then, with rear brakes set and front brakes released, bowl is lowered, pushing prime-mover wheels forward as wheel-base lengthens. Process is repeated, 'til drive wheels are on firm ground.

Easy loading

Large "target" (8'9" x 10'10" — on "C" Rear-Dump) permits easy loading without spillage. Rear of body provides wide, low entry for dipper — to give extra speed advantage for your shovel. By reducing cycle time, big-capacity Rear-Dumps make every load a profitable one!

Fast dumping

At touch of a dashboard switch, point-of-action electric motor instantly raises bowl to any desired angle. At full dump position, edge of bowl is behind and below rear wheels, so material cannot roll forward to lodge against wheels nor pile under rear end. Streamlined body sheds stickiest material readily.

Short 180° turns

"C" Rear-Dump makes continuous 180° turn in space only 28'8" wide. With body in dump position, unit can turn 180° in only 20'8"! This unusual maneuverability of L-W Rear-Dumps allows you to work in tight quarters where smaller conventional haulers often cannot go.

3 sizes; interchangeable work units

Tournapull Rear-Dumps are available in 3 sizes; 11, 22, and 35 tons. Behind basic prime-mover, other trail units — such as scraper, bottom-dump, lift-and-carry crane, logging-arch, and flat-bed hauler—can be interchanged. For just a small additional investment, they'll keep your Tournapull prime-mover profitably busy all year-around! Call or write for complete details.

R-1410-G-b

LeTourneau-WESTINGHOUSE Company, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

AT HOME IN THE ROUGH

NAYLOR PIPE is as Distinctive in Performance as it is in Appearance

Don't let the light weight of Naylor pipe fool you. Built into its light wall is an exclusive spiral lock that gives this pipe extra strength and safety not found in other pipe of the same wall thickness.

This means that you can rely on Naylor pipe to do the job no matter how rough the going. Suspend it. Support it. Bury it or install it on the surface. It's at home in any setting, always ready to handle air, water, tailings, hydraulicking—and similar service in mining operations.

Remember—along with this outstanding performance, Naylor pipe gives you savings in time, work and material. That's why it will pay you to get the complete story. Just write for Bulletin No. 507.

NAYLOR

NAYLOR PIPE COMPANY
1243 East 92nd Street, Chicago 19, Illinois

Eastern U.S. and Foreign Sales Office:
60 East 42nd Street, New York 17, New York

WHAT BUT A BELT CONVEYOR could carry this load for so few pennies a ton?
Moving at high speed—24 hours a day if required—belt conveyors handle huge tonnages in a continuous stream. Loading and unloading delays are eliminated, and there's no time lost on empty return runs. Operating costs are relatively low, based on cost per ton handled. In fact, economies of belt conveyor operation and upkeep generally top any other form of bulk material transportation. And thanks to their extreme flexibility, installation is easy even in difficult locations.

WHO BUT LINK-BELT offers such a complete belt conveyor service? For any requirement—new installation or modernization job—Link-Belt will plan it, equip it, erect it and stand behind it. Our engineers can choose from industry's most comprehensive idler line—plus a broad range of pulleys, drives, terminal machinery and auxiliary equipment. Because all drawings and equipment come from one source, responsibility is centralized . . . no need to waste valuable engineering man-hours coordinating drawings from several sources.

OVERALL ENGINEERING

COMPLETE EQUIPMENT

SKILLED ERECTION

ASSURED SATISFACTORY PERFORMANCE

Add to the basic economies of belt conveyors the extra advantages offered by Link-Belt—it's a formula producing lower costs per ton for all industry. Your nearby Link-Belt office can furnish complete information. 14.621

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs.

High altitudes, narrow benches severely test this Michigan, yet every day it loads

400 tons of rock weighing 5,400 lbs per cubic yard

Up in the scenic Sapphire Mountains of southwestern Montana, Cummings-Roberts Company has one of the toughest rock-loading jobs you could find anywhere.

Part of the time, they blast and load coarse mountain-top granite . . . summer and early fall, they load fluorspar. No one needs to detail what a severe test the heavy, rough granite overburden gives to *any* loader. Fluorspar, however, is even worse. A heavy rock mineral, it weighs 5,400 pounds per cubic yard—over 850 lbs more per yard than in-bank granite (and 2,200 lbs more than pit-run gravel).

Proved by demonstration

Over the years, Cummings-Roberts has tried just about every kind of loader made. Last year to increase efficiency, their Michigan distributor, Miller Machinery Co., Missoula, suggested a Model 175A Michigan Tractor Shovel. "Frankly," Cummings-Roberts officials told them, "we don't believe *any* rubber-tire unit can load the stuff, much less do the work day in and day out. But we'll give it a try."

Result? John Taber, General Superintendent, wouldn't let them take the Michigan off the job.

Heaped loading assures proper blending

Today, the 133 hp 2¾ yard Michigan handles *all* loading of the super-heavy fluorspar. Production, with trucks on 600 ft one-way hauls to crushing mill, averages 400 tons per 7-hour day. The fluorspar, incidentally, varies considerably in grade from place to place through-

out the mine. It must be blended to give the grade desired for shipment . . . and this assignment goes to the Michigan, too. Its 27 mph mobility is a vital asset on this scattered loading; trucks never wait more than a few minutes for loading service.

Strips granite overburden — 500 tons per day!

In late autumn and sometimes in spring, the Michigan strips the granite overburden. Output averages *500 tons* per 7-hour day.

Downtime negligible

With all this rugged loading of super-heavy material, plus repeated back-and-forth maneuvering on narrow benches, plus continuous work at high 6,800 to 7,000 ft altitudes, the torque converter equipped Michigan has posted an excellent mechanical record. *To date, it has had only one minor breakdown!*

Also tows compressors, speeds other odd jobs

Operator Don Lindblom likes Michigan's powershift transmission, says its bucket action is the best he's ever worked with. "You can tip it back and fill it easily," he says. "I like the fact also that it takes only half-an-hour per day to refuel and lubricate." Foreman Waino Lindblom adds, "The Michigan has done a nice job for us! We particularly like its truck-like speed in moving from bench to bench." This mobility gives the Michigan some "spare time" to handle maintenance jobs scattered along 15 mi of mountain roads—cleaning rock rubble off benches so trucks and wagon drills can get through . . . hauling air compressors . . . digging culverts . . . even plowing snow.

Got a tougher job than this?

There *may* be a tougher materials-handling job than loading granite and fluorspar . . . but we're willing to bet a Michigan Tractor Shovel can do it faster, better, at lower cost than any other machine. To prove it, your Michigan Distributor will be glad to arrange a demonstration at *your* convenience. *You pick the jobs.*

CLARK® EQUIPMENT

Michigan is a registered trade-mark of
CLARK EQUIPMENT COMPANY
Construction Machinery Division
2465 Pipestone Road
Benton Harbor 33, Michigan
In Canada: Canadian Clark, Ltd.
St. Thomas, Ontario

ON THE go

by J. Hall Carpenter

AFRICAN COLUMBITE PRODUCTION will be increased in two plants that have recently installed Carpco high tension separators and revised their flow sheets. Improved recovery will boost their production above that obtained with the systems previously employed. The high tension separators are used at the head of the flow sheet to separate columbite and cassiterite from zircon, and the other silicate minerals present.

THE NEW LABORATORY MODEL HIGH TENSION SEPARATOR is now in full production. This completely redesigned unit, Model HP167, incorporates many new features including an airlift for the circulation load that does not pass material through the blower, a preset feeding device for more precise rate calculations, more shielding and many others. The use of silicon rectifiers for variable speed rotor drive has eliminated the use of tube rectifiers and rheostats. Bulletin HPB-103 describes the separators completely.

RETURNING FROM AUSTRALIA, FRED L. STUBBS will take the position of head engineer on plant design for Carpco Research and Engineering in Jacksonville, Florida. For the past one and one-half years, he has been acting as Technical Manager of Carpco AUSTRALASIA in Brisbane.

THE SEPARATION CHARACTERISTICS OF MINERALS CHART compiled by Carpco from many years of experience in electrical separation of minerals has been revised and brought up-to-date. It outlines mineral behavior characteristics with respect to gravity, high tension and magnetic separation, individually or in combination. Prints of this chart are available on request.

Carpco

CARPCO RESEARCH AND ENGINEERING • CARPCO MANUFACTURING, INC.
CARPCO CONSTRUCTION CORPORATION • CARPCO EXPORT CORPORATION
JACKSONVILLE, FLORIDA, U. S. A.

Why Wyandotte Chemical Corp. chose this dozer *(a Michigan)*

"Like most quarries, we have a lot of widely-scattered, repetitive jobs to do," writes William Hagen, veteran manager of Wyandotte's big Alpena, Michigan, limestone quarry. "Trouble was, our crawler-dozers just couldn't handle 'em efficiently—moving, as they must over rocky surfaces, at only a couple of miles per hour. And the cost of track maintenance was pretty awful. Major cause of track wear is travel, of course . . . so we tried to limit *both* as much as possible by putting a crawler on each operating level and another on the stockpiles. Didn't help much, though. Breakdowns would still upset our schedules *several days per week*. So we decided to look at some rubber-tire dozers." They tried one type. It was unsatisfactory. Then Wyandotte's local Michigan Distributor, Michigan Machinery & Equipment Co., arranged an on-the-job demonstration.

Makes hour crawler move in 7 minutes

"From the moment our trial Michigan drove off the flatcar, it was *busy*," Hagen continues. "First job on the docket was leveling a dump area on our macadam storage pile. The Model 180 dozed enough area to last an 8-hour shift —in only 28 minutes! Then, because *two* of our crawlers were down for repairs that day, we drove the Michigan a mile to our shovel loading area. *In less than 4 minutes* it was at work, cleaning up ahead of the 6 yard electric shovel and opening the way for trucks. Half an hour later, we moved back to macadam storage —a 3-minute trip this time. One of our crawlers would have taken a whole hour for the 2 mile round trip alone! Later, the Michigan assisted in moving our big quarry shovel; transfer of the power feed cable and area cleanup were handled faster than ever before. We also used the Model 180 Dozer to move drilling machines, air compressors and shanties . . . to strip shallow overburden . . . clean around the surge bin . . . maintain roads . . . and to level the flux-stone stockpile. Nowhere in these operations did the Michigan have a bit of trouble. With performance like *this*, we were sold!"

Only 1 repair job in 5,800 hours

Hagen finds their Michigan today does all of these tasks and many more around this 450-acre quarry. The Model 180 actually works 16 hours a day, 7 days per week. Quarry Superintendent B. C. Raymond estimates its tire wear to be *1/6 as costly* as track maintenance on the crawlers. Its mechanical efficiency has been excellent . . . in the past year, it has been down for repairs *only once*. Operators say "Michigan drives like a new car . . . avoids constant jarring of a crawler . . . gets us on the spot *fast* . . . has fine visibility fore and aft. *We like it!*"

Want to move in on bottlenecks too?

We'll bet a Michigan Dozer can break production bottlenecks for *you*, too. Won't cost you a cent to find out—your local Michigan Distributor will be glad to arrange a thorough demonstration. You pick the time. You pick the job. No obligation, of course. And ask him about the popular Clark Lease-Purchase Plan, which lets you put a Michigan to work without investing a penny of capital. Other finance plans available—choose the one you like best!

Michigan is a registered trademark of

CLARK EQUIPMENT COMPANY
Construction Machinery Division
2465 Pipestone Road,
Benton Harbor 35, Michigan
In Canada: Canadian Clark, Ltd.,
St. Thomas, Ontario

CLARK® EQUIPMENT

Have you tried the new dipper teeth...

that are already saving money for all major mining companies on the Iron Range?

Facts about Wearpact® Steel

The best combination of hardness and toughness available anywhere

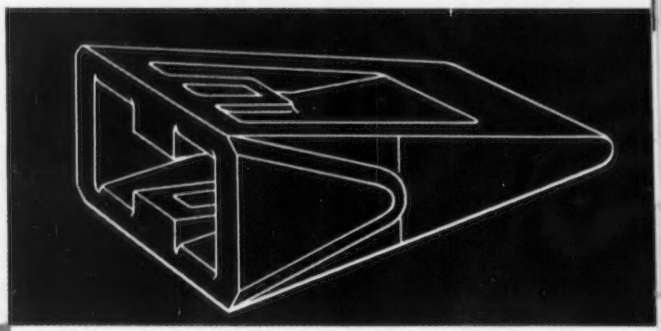
About 2½ years ago, a new alloy was developed with unusually high hardness—477 minimum Brinell—and yet was *tough*. Able to stand up, without flow or distortion, under the worst kind of abrasion and impact. Now used with excellent results on crusher liners, grousers, end bits, corner shoes and cutting edges.

Today, for example, only 30 months later, every major mining company on the Iron Range is using Wearpact Steel teeth. And what a record these teeth have made! Reports from a taconite mine, where service conditions are worst of all, show that manganese teeth last an average of 3 shifts—with two repointings. But the same reports show that Wearpact Steel teeth average 12½ shifts—*straight through*. No more pulling teeth off the shovel after each shift; no more piles of teeth in the welding shops, each waiting for an expensive rebuilding job.

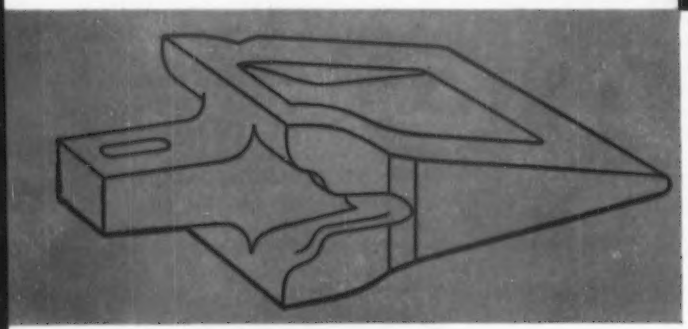
Hardness and toughness alone didn't account for all this increase in service life. The Wearpact teeth were of a different design . . . with long, sweeping cutting edges that stay sharp; *slice* rather than ram through the ore. No other commonly used alloys would permit designs like these; only Wearpact has the necessary tensile strength and high yield point. And remember; you don't work-harden Wearpact. It's hard—clear through—as shipped. Teeth are ready for tough service the minute they're installed. No hardfacing needed.

How much money can Wearpact Teeth save in YOUR mine?

That depends on your operating conditions, of course. Find out for yourself—with your own cost figures—that Wearpact can save money for you, as it has in other mines. Now is the time to arrange for a test of Wearpact. Write today for name of your nearest ASF Representative, or use the coupon below.



WEARPACT Style 3

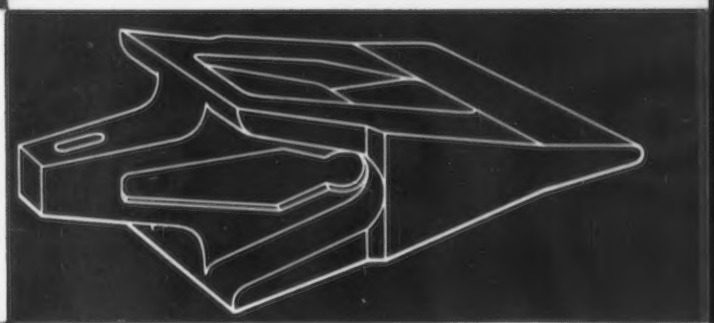


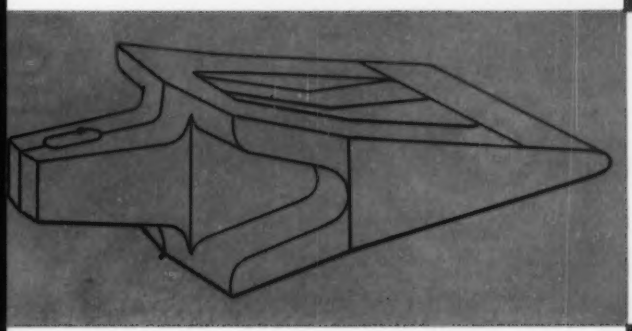
WEARPACT Style 1

Typical Wearpact Steel teeth now used in leading mines

WEARPACT Style 5

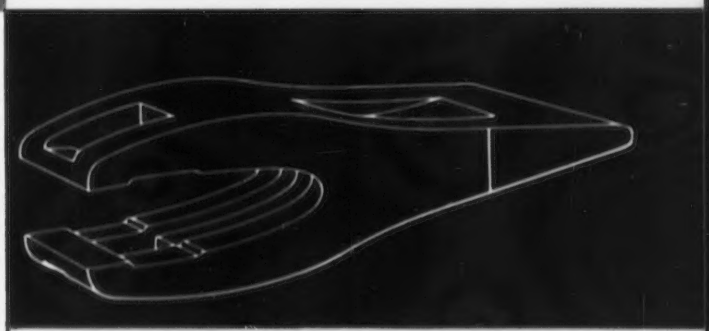
WEARPACT Style 7





WEARPACT Style 11

WEARPACT Combination Tooth and Base



WEARPACT®

was developed in the research laboratories of

AMERICAN STEEL FOUNDRIES

World's largest producers of fine cast steel

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American Steel Foundries
Industrial Castings Division
3700 Canal Street
East Chicago, Indiana

☐ We are interested in testing Wearpact Teeth. Have your representative contact us.

☐ Send information on Wearpact Teeth, and other mining applications for Wearpact Steel.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

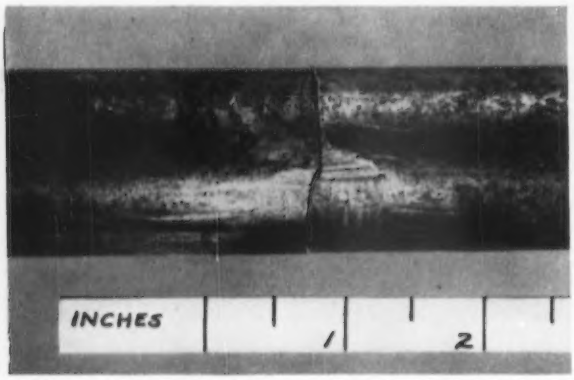
how to get the most out of HOLLOW DRILL STEEL

In a modern jackhammer, hollow drill rods must take between 1800 and 2000 jolting blows per minute. It's pretty rugged treatment for *any* steel – even Crucible's special alloy CA DOUBLE DIAMOND or 4E Hollow Drill Rods. That's why it's so important that you prevent unnecessary *abuse* of drill rods on the job. Here are a few tips that may save you time and money.

Take, for example,
DRILLING METHODS

ROD ALIGNMENT – A little extra care in properly aligning the drill rod so that the force of the piston is transmitted to the rock in a straight line will help reduce breakage a surprising amount. For bad alignment sets up severe stresses in the steel.

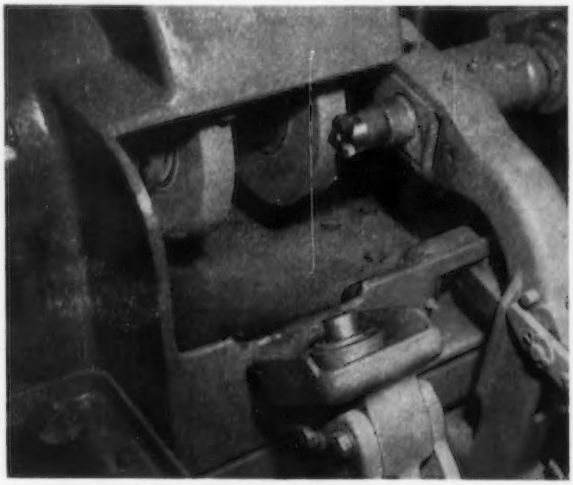
RATE OF FEED – Too slow a rate of feed forces the rod to absorb much of the impact – without a proportionate amount of hole being drilled. Too fast a rate results in a high breakage rate. Alloy rods – Crucible CA DOUBLE DIAMOND or 4E – allow faster drilling speeds than straight carbon drill rods used under the same conditions. That's because these alloy rods have higher hardness, tensile and yield strengths. The harder, more elastic alloy rod transmits the piston blow more efficiently than does the straight carbon drill rod.



Careless handling caused surface damage which resulted in a broken rod.

SURFACE DAMAGE – Damage to the surface of a drill rod may often lead to a broken rod. Nicks or deep tool marks cause stress concentration at the damaged spot.

BITS – Drilling with bits that have dull edges or gages badly worn creates a strain in the drill rod that prevents maximum efficiency. It pays big dividends to keep bits in good shape.


Sharp bits pay off in drilling efficiency.

Actually, the solution to lower drilling costs–longer drill life–is simple: First, use the *right* drill rod and, second, apply a little extra care and common sense to machine setup and operation. It's well worth the effort.

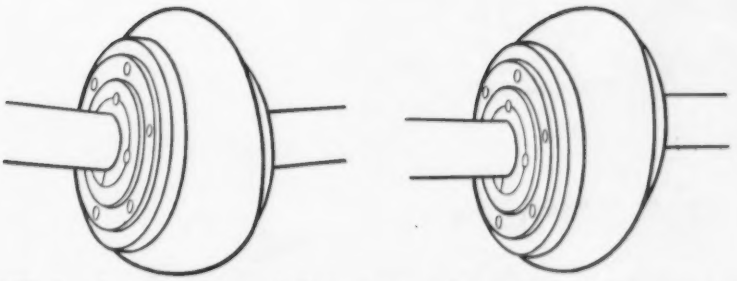
Your nearby Crucible representative can give you helpful hints on other phases of drill rod care and operation–or arrange for *prompt* delivery of hollow drill rods in the sizes, types and grades you need. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

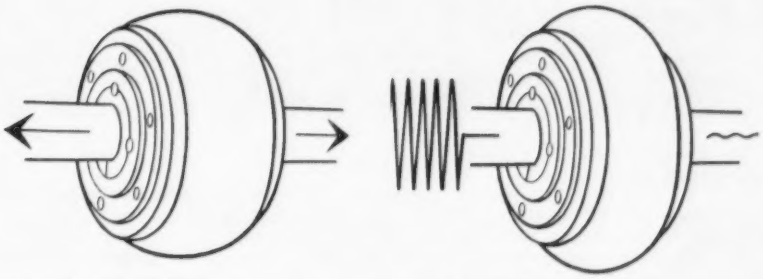
Crucible Steel Company of America

E&MJ NEW PRODUCTS DIGEST

James W. Franklin



USE Para-flex for angular misalignment . . . for parallel misalignment . . .

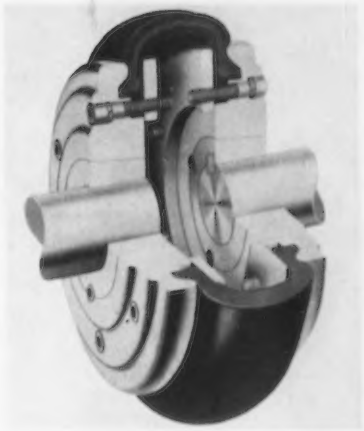


to take up end float . . . and absorb vibration.

Dodge Para-flex Coupling Handles Three Types of Misalignment (3)

Para-flex, described as a wholly new concept in flexible couplings is now available from Dodge Mfg. Co. in popular transmission sizes. Para-flex will be available from factory stock in capacities from 4 hp at 1800 rpm to 600 hp at 900 rpm.

According to Dodge engineers, Para-flex will take angular misalignment up to four degrees, parallel misalignment up to ⅛-in., and end-float up to 5/16-in., depending on the size of the coupling and the length of service; or it will take all of these three types simultaneously.

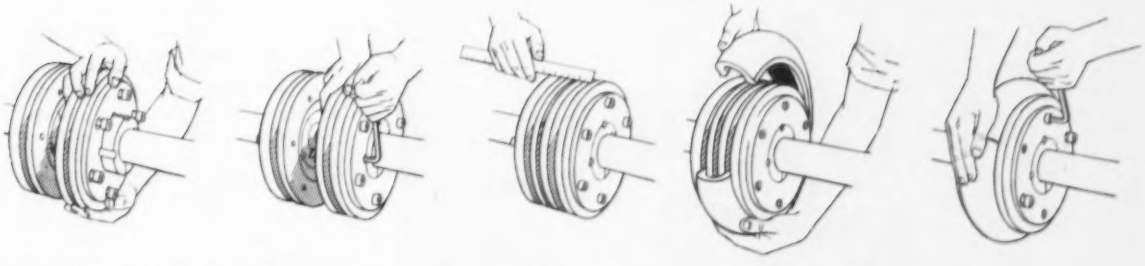


The coupling consists of a flexible, split rubber tire clamped between two hubs, which are mounted on the shafts to be coupled. Flexible member is held between the flanges and clamp rings of the hubs. Both hubs are machined to take Taper-Lock bushing.

In addition to handling misalignment, the coupling cushions shock load and reduces torsional vibration, protecting both the driver and the driven machine, providing longer unit life.

In addition to its many advantages, the Para-flex coupling is easy to install, maintain and replace. See sketches below showing installation instruction. No lubrication is required. All cap screws are countersunk. There are no protruding parts. Para-flex was designed in Germany and is already in wide use on the Continent of Europe and on some Canadian railroads.

How to Install the Dodge Flexible Coupling



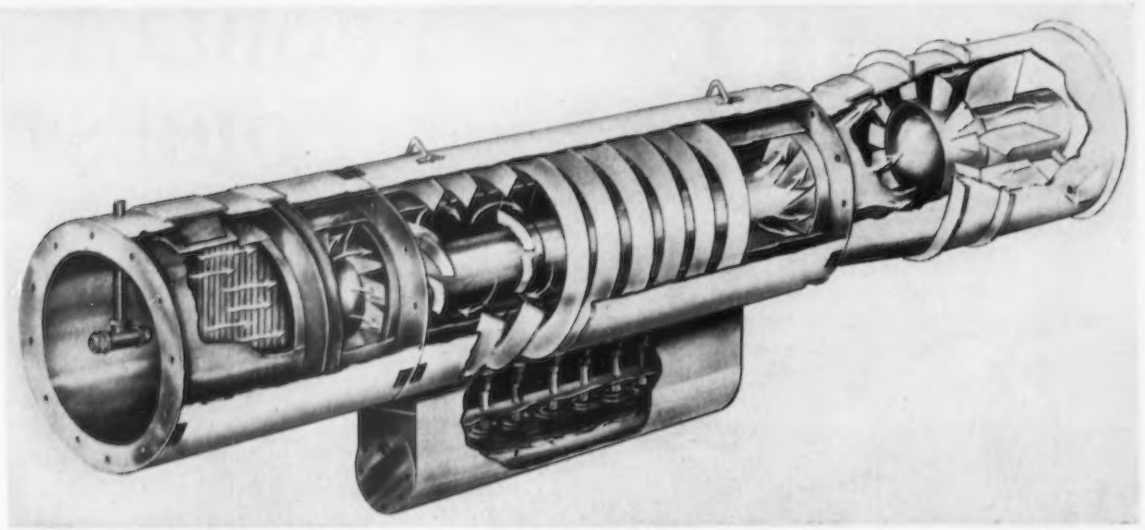
SLIDE flanges on both shafts.

LOCK the hubs onto shafts.

MEASURE for correct space

WRAP tire in clamp rings.

SET cap screws to hold tire.



Impingement Type Dust Collector Cuts Costs, Saves Space (3)

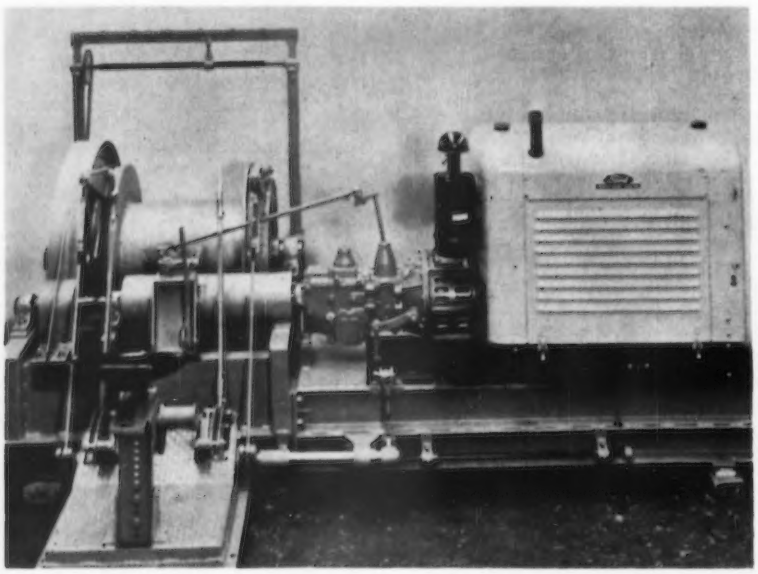
Joy Mfg. Co.'s Microdyne dust collector is only 5 to 10% the size of presently available dust collectors of comparable efficiency. New unit is a wet inertial collector that will collect up to 99% of all plus five microns. Microdyne is the result of an idea brought to Joy by Jack Warren, chief ventilation and hygiene engineer, Anaconda Co., Butte, Mont., who says that the Microdyne will make an absolute cut in the ten micron range, it is efficient and economical, and Anaconda has 13 units (with total 250,000-cfm capacity) installed at Butte, in both surface and underground use.

Microdyne is available in a range of sizes from the small, compact, portable 500-cfm units on up to the larger 60,000-cfm designs. Cost is amazingly low. In an installation of 48,000-cfm units at Allegheny Ludlum Steel Corp., Brackenridge, Pa., cost of the unit in stainless steel, less fans, was about 50c per cfm.

Joy intends to sell the unit for mill and plant use, and also for portable or easily moved use in underground hard rock and coal mines.

Small Mine Hoist Uses Twin Disc Fluid Drive (2)

Vulcan Iron Works Co. has developed a small, compact gasoline-operated mine hoist that has a Twin Disc Clutch Co. fluid drive that gives the same smooth control with the gasoline engine that you would normally expect from an elaborate and more expensive electric hoist. Vulcan's hoist is powered by a Ford motor and transmission, offering an added advantage that spare parts can be obtained from the nearest Ford dealer, who will have the parts in stock. Two models are available with 45/75 and 75/100 hp ratings. Rated pull is 2,000/4,000 lb and 5,000/7,500 lb respectively. In addition to fluid drive, the hoist features double post brakes, forward and reverse transmission and spring mounted operator's seat. Hoist can be used in vertical or inclined shafts and meets mine safety laws of all states (photo below).



Roebling Opens Continuous Vertical Wire Vulcanizer

Process has been developed and is in operation at John A. Roebling's Buckthorn, Trenton, N. J. plant that can vulcanize on a continuous basis rubber or neoprene covered cable in any desired length for wire diameters up to 2¼-in. The machine extrudes and vulcanizes in downward vertical position, thereby reducing abrasion damage to the cable cover. Electrical cable users, we were told while touring this new installation recently, are using longer and longer cable lengths. Big reason for the increased demand in longer lengths is that the user can cut his cable as desired, and handle the longer runs on one spool, reducing his scrap accumulation.

(*Continued on p 39*)

LOADS 2 CU. YDS. PER PASS

quicker...easier... at less cost per yd.

For big yardage production, no other crawler in its class can match the combination of power, speed and maneuverability you get with the new 2 *cu. yd.* Case® TerraTrac® Model 1000 tractor-shovel. It not only gets bigger loads faster . . . it also turns and maneuvers faster with a new *COUNTER-ROTATING* Terramatic transmission that drives one track *forward* and the other track *reverse* at the same time.

Exclusive "Knock-out" dumping action cleans bucket instantly of stickiest material, while extra-high (9'6") clearance lets you back away from big trucks or hoppers without stopping to raise bucket. You also get *exclusive torsion-bar track suspension, automatic track roller lubrication,* PLUS many other advanced features that will increase your production, cut your costs.

See this revolutionary higher-speed 2 cu. yd. rig now at your Case Industrial Dealer's, or mail coupon for catalog and free eye-opening demonstration.

Torque-Converter Drive

Ordinary Drive

100 HP Diesel plus torque-converter drive

Develops up to 24,000 lbs. of "crowding-power" for digging hard materials. Converter automatically balances tractor speed to changing loads . . . eliminates clutching and gear-shift guesswork . . . keeps engine and hydraulic pump operating with maximum power at all times.

Power-Turn

Brake-Turn

Spin-Turn

Instant power-shift with 3-way power-steer

Enables you to change speeds or directions "on-the-go", without stopping to shift gears. Easy-working hydraulic controls let you turn and maneuver full loads easier — with power and traction on both tracks.

CASE INDUSTRIAL

1st in quality for over 100 years

Clip . . . mail for free catalog

J. I. CASE CO., Dept. G1377 Racine, Wis., U.S.A.

☐ Send catalog on new 2 cu. yd. tractor-shovel

☐ I'd like a free demonstration on my job

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Company .....

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CT-L-56

Industrial Wheel and Crawler Tractors • Loaders • Dozers • Backhoes • Engines

..JOY DRILL JIB/TRACTOR COMBO

CUTS DRILLING COSTS 56¢ A TON!

A uranium mining company made their own Drillmobile by mounting two Joy LM-67 Drills with 6′ chain feeds and Hydro Drill Jibs on a diesel tractor. Result was an 80% reduction in labor costs!

This "Jib-Tractor" drills two faces a shift. Each face consists of 120 to 130 holes, is 18′ wide, 18′ to 20′ high. The Joy extendable Jibs drill horizontal holes up to the 18′ height and slanted holes at 20′.

Drilling speed in sandstone ranged from 30″ to 36″ per minute. Average footage drilled and broken is 7 feet. Ground broken per round is about 150 tons. Previously, air legs and stopers were used for drilling. The table at right illustrates the saving in drilling costs with this new "Jib-Tractor."

Write for Bulletin 87-F to ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

FORMATION	Sandstone
DRIFT SECTION	18′ x 20′
HOLES PER FACE	120 to 130

	Jib-Tractor	Air Legs & Stopers
Rounds drilled per shift	2	½
Tons broken per shift	300	85
Labor cost per shift	$40	$60
Labor cost per ton	14c	70c
Saving per ton	56c	—

Consult a Joy Engineer

for AIR COMPRESSORS, ROCK DRILLS, HOISTS AND SLUSHERS

W&D M 5505

JOY

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING EQUIPMENT

Motor Truck (15)

International Harvester Co.'s line of light-duty, medium-duty and heavy-duty trucks in a selection of four- and six-wheel drives, in conventional and cab-forward design, are now available. Horsepower ratings go up to 154.

Bowl Scraper (16)

Two new drawn scrapers are available from International Harvester Co. One is 4S-85, the 20 cu yd (heaped) and the other is 4S-55, a 14 cu yd (heaped) bowl scraper. New feature is an adjustable cutting edge which consists of three interchangeable, reversible segments that permit the operator to shift from one to the other to match soil conditions.

Bowl Scraper (14)

No. 491 Caterpiller Scraper replaces No. 90 in company line. New model has 27 cu yd capacity (struck) and heaped capacity of 34 cu yd. Apron has 15 in. more opening space than old version, and is fitted with tubeless tires, according to Caterpillar Tractor Co.

Wheel Tractor (17)

Model 320, by J. I. Case Co., is a unit tractor containing front-end loader and backhoe. Loader bucket is ½-cu yd capacity. Both tools are hydraulically controlled.

Rubber-Tired Shovel (18)

Model SP-107, by Thew Shovel Co., is a self-propelled machine mounted on rubber-tired carrier with four-wheel drive. Power-take-off on the turntable is through an automatic transmission and torque converter. Machine is fully convertible to shovel, crane, clamshell, drag and hoe.

Diaphragm Pump (35)

Rice Pump & Machine Co.'s lightweight diaphragm pumps use a one-step worm gear drive between the engine and pump for speed reductions. Unit may be had with or without power. Will operate from motor or engine.

Gate Valves (36)

Jenkins Ni-Resist Type 2 cast iron gate valves with type 316 stainless trim are available for handling corrosive or erosive fluids or gases, according to Jenkins Bros.

Moly Lubricant (23)

Locomotive may get 30 to 300% longer wheel life with a flange lubricator now being marketed by National Aluminate Corp. Called Moly-Stick, this molybdenum disulphide will not pick up dirt and sand that turn ordinary greases and oils into abrasives.

Two-Part Vibrator (37)

Air-operated vibrator developed by Cleveland Vibrator Co. has only two parts plus the optional mounting base and weighs only 60 lb in the 2-in. KO Model and 79 lb in the KO 4-in. Vibrator is permanently lubricated with molybdenum disulphide for lifetime protection.

Continued on page 40. For more information on items, use card opposite page 42.

Endless shaking, vibrating or pounding doesn't alter the slot openings of Bee-Zee Screens. Screen rods are welded at every point of contact to tie rods...fused perfectly and precisely by electronically-controlled welding equipment.

Shape and thickness of rod...shape and size of screen...width and length of slot – these are always custom-selected when you order Bee-Zee Screens. Special alloy stainless steel resists abrasion...can't rust or corrode. Built-in tension fights fatigue.

Write, wire or phone Galesburg 4397 collect for catalog and specific information on screens for your sizing, deliquefying, filtering or other screening operation.

ROUND-ROD SCREEN
long-life accuracy

GRIZZLY ROD SCREEN
rugged accuracy

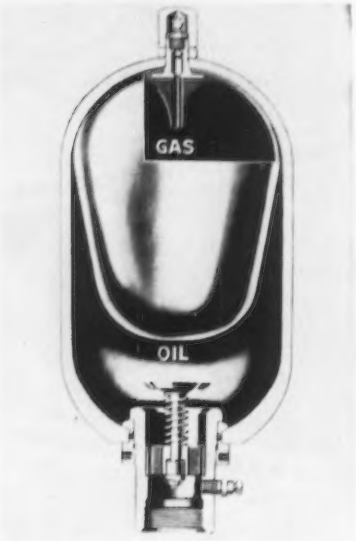
ISO-ROD SCREEN
prolonged accuracy

TRI-ROD SCREEN
knife-like accuracy

GRIZZLY ROD WITH SKID ROD
ruggedest accuracy

BIXBY-ZIMMER
ENGINEERING COMPANY
577 Abingdon Street, Galesburg, Illinois

New Tools for Metallurgists

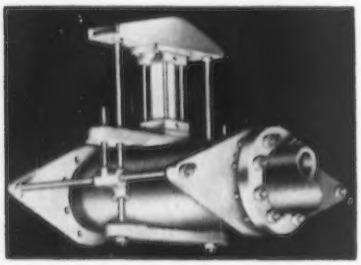


Hydraulic Accumulator (26)

Bladder-type accumulator is free of all possible inertia and friction forces, and absorbs 95% of the hammer and pulsation in a pump pipe line. Unit is designed for hydraulic pressure systems by Greer Hydraulics, Inc.

Cold Vulcanizing Paste (27)

KA-VU no-patch cold vulcanizing paste will repair any rubber article from boot, glove and apron to conveyor belt. Compound won't dissolve in water, and is as heat and acid resistant as rubber. No patches are needed, according to Richard J. Kern, U. S. importer of this Swiss development.

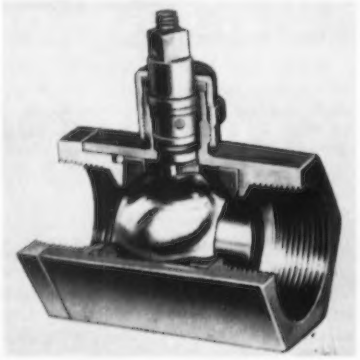


Air-Operated Pinch Valve (28)

New models of Massco-Grigsby pinch valve feature the Hydral-Air operated mechanism for easy, fast opening or closing. It can be equipped for automatic regulation where it is essential to control liquid level or flow. According to Mine & Smelter Supply Co., the valve is available in 1- to 14-in. dia, for pressures to 150 psi and temperatures up to 200 deg F, in rubber or Neoprene sleeves.

Aluminum Foot Valve (24)

Designed by Clayton Mark & Co., aluminum foot valve with strainer weighs only 41 lb for the 8-in. pipe size. Valve for 6-in. pipe weighs 19 lb. Valve is resistant to corrosion and mechanical damage, according to Clayton Mark & Co.



High Vacuum Valves (33)

NRC Equipment Corp. is making high vacuum ball valves in sizes from ¼ to 6 in., in either manual or air motor design. They can furnish valves in bronze, aluminum, mild steel, 303 and 316 stainless or polyvinyl chloride.

Apron Feeder (34)

More than fifty types and sizes, including two portable models in the Pioneer Engineering Division, Poor & Co., Inc. newly redesigned line are now available. Unit feeders are available with standard pan widths of 30, 36, 42 and 48 in., and in standard lengths of 4, 6, 8, 10 and 12 ft.

Dry-Type Transformer (25)

Fire and explosion-proof sealed dry-type transformers in the 5-kv class and below are now available for underground service from Allis-Chalmers Mfg. Co. This model above is 225-kva, 3-phase, 60-cycle, 150 deg C rise, air-cooled.

Pinch Valve (31)

Red Jacket Co., Inc. has developed an 18-in. dia pneumatic rubber pinch valve to add to their line of air or hydraulic operated pinch valves in ¼- to 36-in. size.

High Tension Separator (32)

Laboratory and pilot plant Model HP 167, is available from Carpco Mfg., Inc., with feed rates possible up to 300 lb per hour. Separation is accomplished by a beam-type electrode and a compact air-lift for recirculating loads.

Single-Toggle Jaw Crusher (29)

Heavy duty single-toggle jaw crusher (Model ST) combines the best features of single-toggle and the heavier double-toggle machines, according to Allis-Chalmers Mfg. Co. It is available in 30x42- and 42x54-in. sizes.

Wedge-Wire Wet Screen (30)

Wedge-Wire Corp. has a new heavy-duty Kleenslot screen for dewatering, wet screening, washing, extracting, filtering or sizing use. Made in stainless steel, G187 and GB187 Migh-Tee Kleenslot screens have standard openings of 0.01-in. and up.

Continued opposite page 42. For more information on these items, use card opposite page 42.

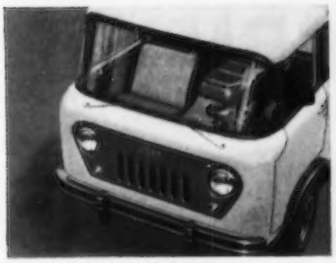
NOW

Another New and Bigger Forward Control 'Jeep' Truck

Here's the bigger, more powerful, 7,000-pound GVW Forward Control 'Jeep' FC-170 Truck:

- **Advanced Forward Control design!** The same new, advanced features that made the Forward Control 'Jeep' FC-150, an immediate success.
- **More cargo space on less wheelbase!** A 9-foot flatbed pickup box on a wheelbase only 103½-inches long! Bed is 27-inches from ground for back-saving ease of loading!
- **More efficient space utilization!** Compare it with any other 4-wheel drive truck — *only* the FC-170 gives you so much cargo space per inch of wheelbase!
- **All-time high for "big-load" maneuverability!** The FC-170 is the *only* 4-wheel drive truck to give you "go-anywhere" 'Jeep' maneuverability with a payload capacity of up to 3500-pounds.
- **Other outstanding features!** It's really a 4-wheel drive truck — *not* a modified 2-wheel drive truck, *not* a conversion! High-torque Hurricane 6-226 engine, time-tested and performance-proved • spacious Safety-View Cab • big wrap-around windshield • wide 63-inch tread for ground-gripping stability in off-road travel • shifts easily into 2-wheel drive for highway travel • with power take-off, operates a wide range of special equipment from winches to belt-driven machinery.

The newest addition to the 4-Wheel-Drive 'Jeep' family...ready for the bigger, tougher jobs!



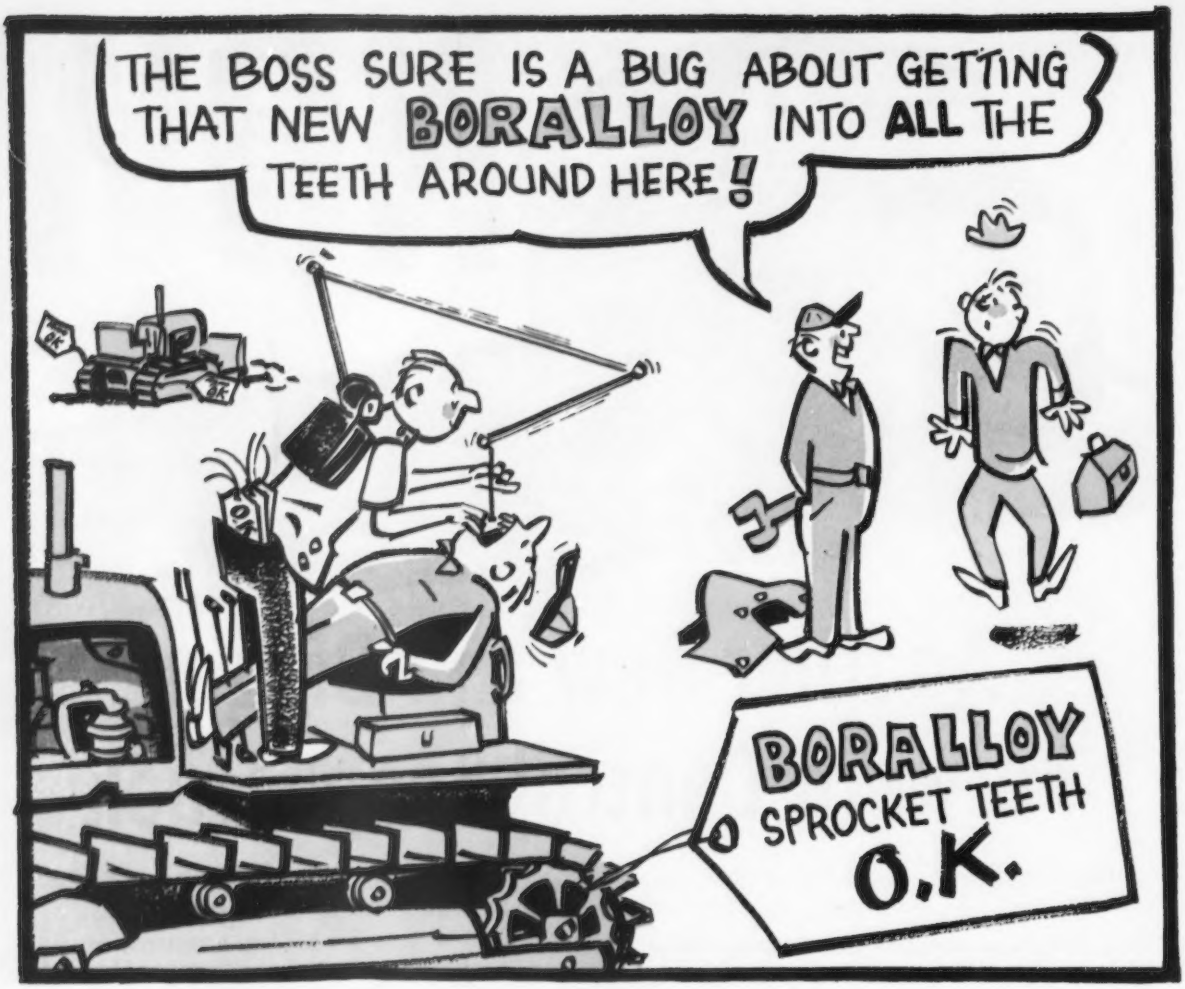
SPACIOUS SAFETY-VIEW CAB puts you in a "Forward Control" position, gives you greater command of any driving situation.

EXTRA 4-WHEEL-DRIVE 'JEEP' TRACTION takes heavy loads to off-road areas impossible for ordinary vehicles to reach.

'Jeep' Forward Control
4-Wheel-Drive FC-170

WILLYS ... world's largest manufacturers of 4-Wheel-Drive Vehicles

Willys Motors, Inc., Toledo 1, Ohio



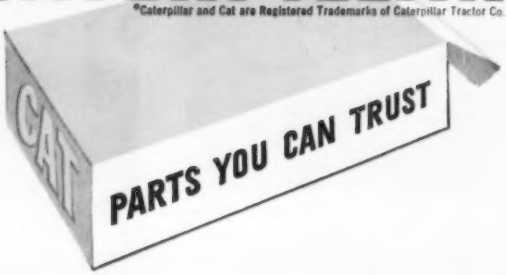
It increases sprocket life 50 to 100%! Got the name?—*Boralloy*. It's a new alloy which Caterpillar uses to make sprockets and replacement rims. It permits a minimum of 61% deeper hardening.

Result: CAT* BORALLOY sprocket teeth hold their contour longer. Teeth and track bushings *stay* in proper mesh, reducing wear and tear on all track running gear. Don't take chances. Get parts you can trust — see your Caterpillar Dealer today! Where else can you get the long-life benefits of Boralloy?

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



E&MJ NEW PRODUCTS DIGEST (*Continued*)———

For More Details on New Product Items and For Copies of Free Literature Listed Below—Circle the Proper Number on Card. Be Sure to Give Your Name and Address.

For Your Files

This selected manufacturers' literature is free unless otherwise specified. If item is for sale, send request and money direct to manufacturer.

EXPLORATION AND MINING

WIRE ROPE recommendations for general contractors has 15 pages and is available from Hazard Wire Rope Div., American Chain & Cable Co., Inc. **(50)**

MOBILE DRILL RIGS by Mobile Drilling, Inc. can be examined in the three 4-page bulletins now available from the company. **(51)**

MORTAR MANUAL for gun applied linings and masonry contains 24 pp of data and illustrations, and is prepared by Universal Atlas Cement Co. **(52)**

ROCK BOLTING IN NON-CARBONIFEROUS MINES—a summary of current practice, is available from Colorado Fuel & Iron Corp. Good abstract and application report of present-day rock bolting practice. 25 pp. **(53)**

EXPLOSIVES FACT BOOK and catalog available from Atlas Powder Co. describes Atlas line of explosives in 48 pp. Plenty of tables and over 100 illustrations. **(54)**

PREPACKAGED MEALS—a good hot meal anywhere, anytime—is a 15-page elease by Bolton Farm Packing Co., Inc. **(55)**

POWER TRANSMISSION EQUIPMENT in the Clark Equipment Co. line can be examined through their 8-page illustrated bulletin. **(56)**

AUXILIARY EQUIPMENT

MOTOR MAINTENANCE—"how to take step seven" is a 20 page bulletin prepared by Allis-Chalmers Mfg. Co., based on their recently released motion picture of the same name. **(60)**

ASBESTOS TEXTILES—cloth, tape, tubing, lap, roving, cord, wick and rope—are displayed in 16 page catalog-bulletin available from Union Asbestos & Rubber Co. **(61)**

LITHIUM data booklet prepared by the American Lithium Institute has 15 pp, describes the properties, uses and applications of lithium. **(62)**

MAINTENANCE COATING, Hypalon, made by DuPont, the maintenance coating for extreme chemical and heat resistance is described in 4-page release now available from Wilbur & Williams Co. **(63)**

FLEXIBLE METAL HOSE PRODUCTS by Universal Metal Hose Co. are set down in a 12-page condensed catalog. **(65)**

CIRCULATING OIL SYSTEM developed by Farval Corp. is described in an 8-page bulletin. **(70)**

DIESEL ENGINE COMPRESSORS are illustrated in an 8 page release offered by Ingersoll Rand Co. **(71)**

HOW CONVEYOR BELT SERVICE repairs your belting, is the subject of an 8-page bulletin now available. **(72)**

GAS REGULATORS for cylinders, manifolds and pipelines are set down in Air Reduction's catalog. **(73)**

MOTOR MAINTENANCE — "how to make a motor go . . . and go . . . and go . . . and go" has been prepared by Allis-Chalmers Mfg. Co., based on their recently released motion picture of the same name. 24 pp. **(74)**

STEEL BUILDING MANUAL released by Armco Drainage & Metal Products, Inc. has complete information on more than 5,000 steel building sizes and constructions. **(75)**

PLASTIC PIPE AND FITTINGS manufactured by Crane Co. are set down in an 8 page descriptive bulletin. **(76)**

STAINLESS STEEL SHEET AND STRIP catalog produced by Allegheny Ludlum Steel Corp. contains detailed information in 32 pp. **(77)**

WATER SUCTION AND STEAM HOSE catalog sheets released by B. F. Goodrich show what the company has to offer. **(78)**

HELIWELD EQUIPMENT catalog available from Air Reduction contains information on all types of Heliweld machines in 20 pp. **(79)**

JULY 1957

NOT GOOD AFTER OCT. 1, 1957
If mailed in U. S. or Canada

Please send me the catalogs or further information about the items from New Products Digest whose numbers are circled.

1	15	29	43	57	71	85
2	16	30	44	58	72	86
3	17	31	45	59	73	87
4	18	32	46	60	74	88
5	19	33	47	61	75	89
6	20	34	48	62	76	90
7	21	35	49	63	77	91
8	22	36	50	64	78	92
9	23	37	51	65	79	93
10	24	38	52	66	80	94
11	25	39	53	67	81	95
12	26	40	54	68	82	96
13	27	41	55	69	83	97
14	28	42	56	70	84	98

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4	18	32	46	60	74	88
5	19	33	47	61	75	89
6	20	34	48	62	76	90
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8	22	36	50	64	78	92
9	23	37	51	65	79	93
10	24	38	52	66	80	94
11	25	39	53	67	81	95
12	26	40	54	68	82	96
13	27	41	55	69	83	97
14	28	42	56	70	84	98

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E&MJ NEW PRODUCTS DIGEST (*Continued*)

MILLING AND SMELTING

AN INTRODUCTION TO AMIDES, NITRILES, AMIDES AND QUATERNARY AMMONIUM SALTS is the title of a booklet currently being made available by Guest Industrials Ltd. **(80)**

DESIGN STUDY of a 200-tpd gravity and flotation tin plant by Denver Equipment Co. is available. 2 pp. **(81)**

HIGH VOLTAGE AND MAGNETIC SEPARATION is the title of a reprinted article from *Mining Congress Journal* and made available through Carpco Manufacturing, Inc. 4 pp. **(82)**

HOW FLUOSOLIDS ROASTING AIDS GOLD RECOVERY AT DALNY MINE has been reprinted by *E&MJ* for Dorr Oliver Inc. and is available from the company. 7 pp. **(83)**

AGITAIR FLOTATION MACHINE bulletin released by Galigher Co. illustrates the advantages of the Agitair unit. 6 pp. **(84)**

RECIPROCATING PLATE FEEDERS by McLanahan & Stone Corp. are described in 6-page bulletin. **(85)**

SEPARATING DRY COMMODITIES BY SPECIFIC GRAVITY is the main title of two 4-page bulletins prepared by Sutton, Steele & Steele, Inc. to illustrate their air tabling equipment. **(90)**

FERROFILTER, the permanent magnetic separator developed by S. G. Frantz Co., Inc. Engineers, is illustrated in a 6-page bulletin. **(91)**

PINCH VALVES that are resistant to abrasion and corrosion are described in Mine & Smelter Supply Co.'s 8-page release. **(92)**

SWEETLAND PRESSURE FILTER is described by Dorr-Oliver Inc. in a 4-page bulletin. **(93)**

ROLL-O-VENT AIR FILTER bulletin by American Air Filter Co., Inc., has 4 pages and illustrates the automatic action of the filtering device. **(94)**

WATER VAPOR INDICATOR for measuring water vapor content of compressed gases, cutting-off machines, electronic humidity controllers, spectrophotofluorometers, electric hydrometers, pneumatic control valves and the new Microflex chemical proportioning pump are all fully described in American Instrument Co., Inc.'s spiral bound catalog. **(95)**

TWO-CHANNEL RECTILINEAR GALVANOMETRIC RECORDER, developed by Texas Instruments Inc., is described in a 6-page release. **(96)**

INDUSTRIAL GAS CHROMATOGRAPH designed for continuous, automatic analysis of process streams, has been developed by Beckman Instruments, Inc. and is set down in a 4 page release. **(97)**

MILL AND PLANT EQUIPMENT bulletin just published by Denver Equipment Co. shows latest ore dressing and material handling machinery available from Denver. 20 pp. **(98)**

THIRTY-TON TRUCK, Letourneau-Westinghouse Co.'s Model LW-30, is fully described in 19-page, illustrated pamphlet. **(40)**

YOU CAN CUT MINING COSTS AND INCREASE PRODUCTION says International Harvester Co. and the company offers eight pages of case histories to prove it. **(41)**

FOR VERSATILE COMPACT POWER—its the D2, D4 and D6 Caterpillar tractor, according to Caterpillar Tractor Co. in their latest eight-page folder. **(42)**

PT FUEL INJECTION SYSTEM is available in 150 models from Cummins Engine Co., Inc. according to the 11-page, four-color bulletin that describes the system. **(43)**

SAFETY HEADS for unrestricted and instantaneous relief in the 3- to 50,000-lb range are available from Black, Sivalls & Bryson, Inc. according to latest four-page release. **(44)**

STEEL PRODUCT AND WHAREHOUSE catalog released by Crucible Steel Co. of America is 232pp and is tab-indexed for the various kinds of steel available. **(45)**

PUSHBUTTON STATIONS, both heavy duty and standard types, in the General Electric Co. line are described in an eight-page bulletin. **(46)**

ELECTRIC HEADLAMPS and handlamps in the Justrite Manufacturing Co.'s line are covered in detail in the company's new 15-page price-list catalog. **(47)**

CORROSION KEYS FOR ALUMIMUM, published by Reynolds Metals Co., makes extensive use of graphs to tell the yearly corrosion rates of more than 100 chemicals. 6 pp. **(48)**

STEAM TRAPS AND STRAINERS in the V. A. Anderson Co. line can be examined in 4-page catalog. **(49)**

LITERATURE FOR SALE

Procedure Handbook of Arc Welding Design and Practice, 11th edition, is a major revision of this well-known arc welding reference book. Covers all phases of the subject in over 1,300 pp, with 1,100 illustrations. Simulated leather cover. Write direct to Lincoln Electric Co., Cleveland 17, Ohio. Price $3 in U. S.; elsewhere

PLAIN PRIMACORD

Textile-covered, flexible and resilient. Suitable for surface trunk lines and shallow holes where tensile strength and resistance to abrasion and cutting are not required. Tensile strength 125 lbs. 1000-ft. spool 17 lbs.

REINFORCED PRIMACORD

Textile reinforced, tough, resilient, flexible. Recommended for surface trunk lines and deep holes where normal strength and resistance to abrasion and cutting are needed. Tensile strength 160 lbs. 1000-ft. spool 18 lbs.

PLASTIC WIRE COUNTERED PRIMACORD

Armored with wire and covered with plastic material. Recommended for use in deep, ragged holes or with metal or fibre explosives containers, where strength and resistance to abrasion and cutting are essential. Tensile strength 300 lbs. 1000-ft. spool 33 lbs.

BLASTERS AGREE that thunderstorms, high tension lines, power cables — even two-way radios — can be sources of stray electrical currents . . . and that these can cause premature shots under certain conditions.

The best safeguard against such hazards is to use a detonating agent which is insensitive to stray electrical currents.

In primary blasting, use Primacord as the detonating agent in each hole and also as the trunk lines to connect all holes so that they will fire in proper rotation. The entire blast can be detonated from one point on the trunk line — with fuse and cap or electric blasting cap. This final hook-up is made only when all is in readiness and when it is *safe* to fire.

In secondary blasting, use Detacord to prime each charge and to connect all charges, detonating it in the same way.

If your holes are primed with fuse and cap, connect the fuses with Quarrycord.

For more information, see your explosives supplier or write to

PLASTIC REINFORCED PRIMACORD

Covered with tough plastic material, not affected by high Summer heat or Winter cold. Waterproof—resistant to acids commonly encountered. Use for extremely deep holes, river crossings, field shots that must stand for long periods of time and in other wet conditions. Tensile strength 275 lbs. 1000-ft. spool 22 lbs.

DETACORD

Smaller (and less powerful) than Primacord. Core of PETN is textile-reinforced and wax finished. Identified by light brown surface with cross windings of red yarn forming an "X" pattern. Resilient, flexible. An economical detonating fuse for use in secondary blasting, long hole underground blasting and pipe-line ditching. *Not* recommended for primary blasting. Tensile strength 100 lbs. 500-ft spool weighs 8 lbs.; 1000-ft spool weighs 16 lbs.

QUARRYCORD

Used to connect and ignite safety fuse in secondary blasting. Burns progressively with an external flame at the zone of burning — about one foot per second. Flexible — not affected by stray currents. 500 ft. spools. Quarrycord Connectors — 100 in a box.

THE ENSIGN-BICKFORD COMPANY

Simsbury, Connecticut . Since 1836

Primacord and Detacord Detonating Fuse, Ignitacord,® Quarrycord, Safety Fuse, Pyrotechnical Devices and Blasting Accessories

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AT WHITE PINE COPPER MINE

USS "T-1" Steel consistently

*Loader plates last 8 to 12 months longer

At White Pine Copper, USS "T-1" Steel, supplied to 321 minimum Brinell, is used in the bottom and side plates of the conveyor of this loading machine. Also, in the plates on its underside along which the returning conveyor chain slides. Prime requirements here are toughness and high resistance to impact abrasion. Every one of these underground loaders has been overhauled since the mine was opened and, in every case, USS "T-1" Steel has been used to increase durability. The result—8 to 12 months more service life. White Pine maintenance men report "T-1" Steel easier to flame-cut and weld than other steels used for this application.

Also available from United States Steel—our well-known USS High Strength Steels, for many years standards for mining and ore handling equipment.

USS

outperforms other materials

Provides very high resistance to impact abrasion plus superior strength and toughness that keeps equipment in service far longer than before*

WHITE PINE COPPER'S experience with USS "T-1" Steel is typical of the improvements in service that this remarkable steel makes possible.

Wherever they have used it to replace former construction, equipment life has been materially increased. Repair and maintenance costs have been cut. Down time has been reduced. All this means important savings in time and money—savings that are far greater than the difference in initial steel cost.

USS "T-1" Steel is unique. There's never been another commercial alloy plate steel just like it. None better able to stand up to the brutal abuse inflicted on mining equipment . . . and as readily handled in fabrication . . . *and* so economical on the basis of performance.

*Feeder chute liners last 2 to 3 times longer

Hard and flinty copper ore plays hob with ordinary materials. That's why virtually all the feeder and transfer chutes in White Pine's crushing plant are now lined with USS "T-1" Steel. Quenched and tempered to 321 minimum Brinell, USS "T-1" Steel liners, ⅜" thick, have proved far longer-lasting than materials formerly used—give from 2 to 3 times longer service. These "T-1" Steel liners are easy to fabricate, are readily flame-cut to size—a great advantage over cast, anti-abrasive materials.

Here's why USS "T-1" Steel can help you improve your equipment

When you want strength far beyond the ordinary, you can get it with USS "T-1" Steel—for, with a minimum yield strength of 90,000 psi and a minimum tensile strength of 105,000 psi, USS "T-1" Steel is nearly three times as strong as structural carbon steel. This is far higher yield strength than has ever before been available in weldable plate steel. What's more, its strength is not lowered by welding or gas cutting.

For equipment subject to impact abrasion, USS "T-1" Steel can be obtained quenched and tempered to a minimum hardness of 321 Brinell. Even this very hard grade can be welded and flame-cut *right in the field* without preheating. That means you don't have to shut down costly, big-capacity equipment for the many hours generally required for shop repairs.

If your equipment must withstand severe impact abuse, USS "T-1" Steel insures against damage in winter weather. Whether furnished to 321 minimum Brinell or to 90,000 psi minimum yield strength, it has exceptional toughness and resistance to brittle failure, even at temperatures far below zero.

Our new catalog—USS "T-1"—is complete with technical information and offers many practical suggestions for its use that can save *you* money. For your free copy, write to United States Steel Corporation, Room 5630, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS" and "T-1" are registered trademarks.

UNITED STATES STEEL

MINING WITH DUMPTORS

...in open pits...and underground

Follow Koehring Dumptor through a typical load-haul-dump cycle, and you'll quickly see why it has gained such wide acceptance on all kinds of mine hauling, stockpiling, feeding hoppers, etc. First, notice how it saves time at the loader (above). Wide-flared 6-yard body, with low height, provides a big square target — *64 square feet, to be exact* — for loading over either side or end by shovel, dragline or front-end loader. On the haul, Dumptor travels at the same speeds in either direction. *There's no need to turn* — an important advantage when working along narrow ledges, overhead trestles, tunnels, etc. It accelerates fast, climbs 24% ramps or grades with capacity load. That's because there's better than 6 H.P. of *"go"* for every ton of loaded weight. At the dump area, *gravity* tilts the body, dumps the load *in one second*. There's no 15 to 25-second wait for slow-acting mechanical body-hoist — and no expensive hoist maintenance, because *gravity-dump* never balks, never wears out. You get all these advantages *and more* when you haul with heavy-duty Dumptors. See your local Koehring distributor about a demonstration, or write to us for the latest Dumptor® catalog.

Up-grade all the way — Near Mexico, D.F., 3 Dumptors haul rock and sand 600 feet up-hill from mine to hopper. In spite of steep, winding road, and normal loading delays, each Dumptor averages 150 loads per 12-hour day. These heavy-duty, 6-yard haulers, with their high ratio of H.P.-to-weight, can climb mine grades as steep as 24% fully loaded.

Dump time: 1 second — At hillside hopper, Dumptor drives up, body forward. Operator trips a body-release lever, and *gravity* tilts the body — dumps the load instantly. Free-swinging kick-out pan breaks load suction for fast, clean dump when hauling wet, sticky materials — bolts down to floor of dump body when handling heavy boulders like this.

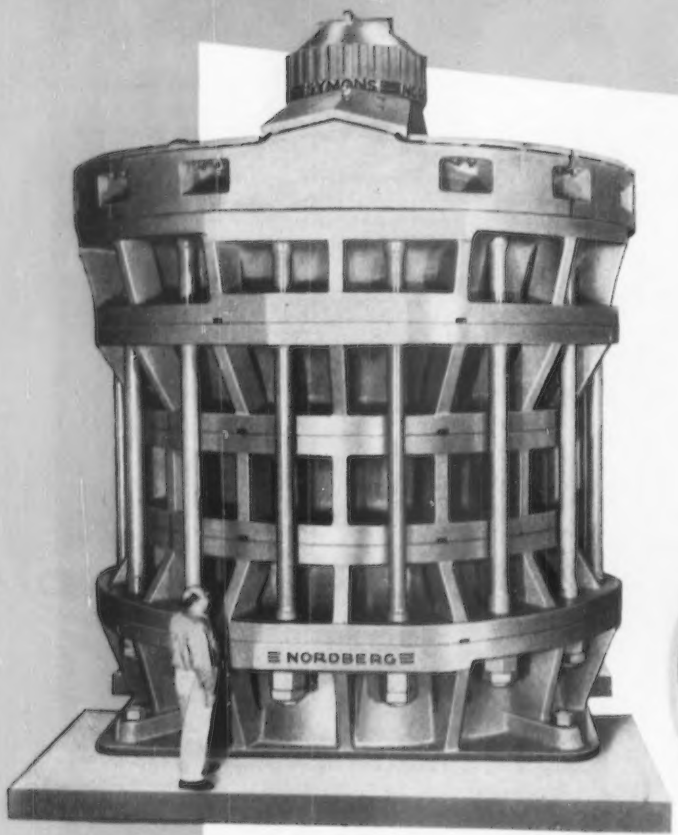
Shuttles underground — There's no room to turn in this mine tunnel, and no need to turn. Koehring Dumptor drives up, gets its load, then shuttles back out of tunnel at the same speed as it entered. It operates with equal ease and speed in either direction — is as efficient underground as it is on inclined ramps, overhead trestles, or hauling on the surface.

An inside job — To save rehandling of materials, 2 Dumptors haul clay from pit to processing plant, dump directly into hoppers inside the plant. Convenient end-dump, and no-turn shuttle hauling are especially practical on operations like this, eliminate turning and spotting in crowded work-areas. Handy, too, for stockpiling, and loading rail cars.

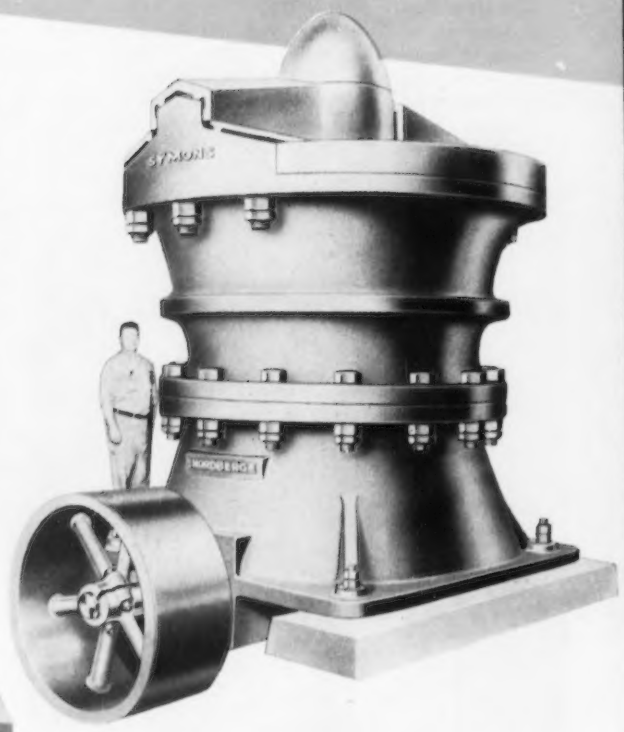
KOEHRING DIVISION OF KOEHRING COMPANY • Milwaukee 16, Wis.

SYMONS®

GYRATORY AND
FOR PRIMARY AND



SYMONS 60" GYRATORY CRUSHER



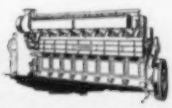
SYMONS 30" GYRATORY CRUSHER

SYMONS
VIBRATING SCREENS

NORDBERG BALL,
TUBE AND ROD MILLS

SYMONS
VIBRATING GRIZZLIES

NORDBERG
MINE HOISTS



NORDBERG DIESEL—DUAFUEL® and
SPARK-IGNITION GAS ENGINES

CONE CRUSHERS FOR FINE REDUCTION

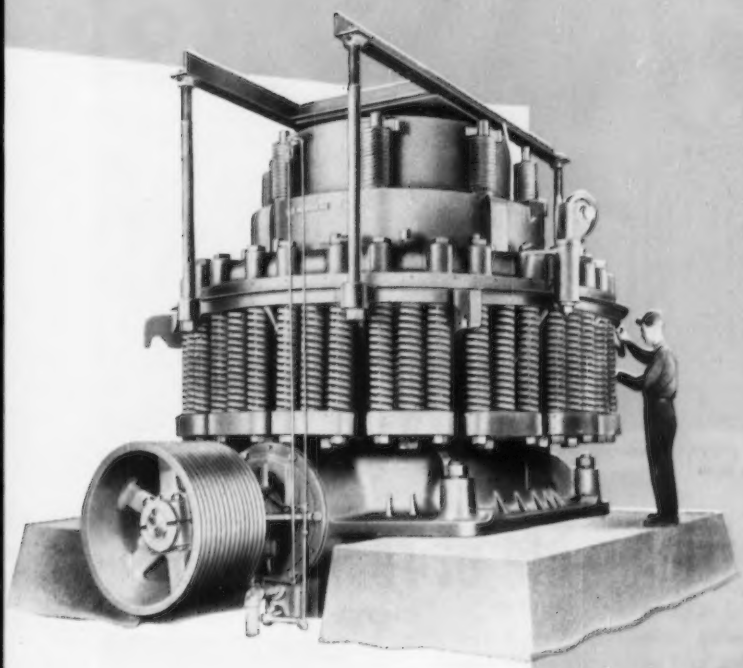
. . . greater productivity through more efficient crushing

Complete range of sizes from 6 to over 3500 tons per hour

All over the world, for big tonnage requirements and heavy duty crushing operations, Symons Gyratory and Cone Crushers are the outstanding choice of the mining and quarrying industries . . . because they *assure maximum and continuous production at low operating and maintenance costs.* For heavy duty primary breaking, Symons Gyratory Crushers are available in 30″, 42″, 54″, 60″ and 72″ sizes, for capacities up to 3500 and more tons per hour. For secondary and finer reductions, Symons Cone Crushers, in both Standard and Short Head types, are available in sizes ranging from 22″ to 7′—in capacities from 6 to 900 or more tons per hour.

Write for further information—Nordberg stands ready to serve you.

NORDBERG MFG. CO., Milwaukee, Wisconsin



SYMONS 7′ EXTRA HEAVY DUTY CONE CRUSHER

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SYMONS . . .

A REGISTERED NORDBERG TRADEMARK

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NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

NEW YORK • SAN FRANCISCO • DULUTH • WASHINGTON
TORONTO • MEXICO, D.F. • LONDON • JOHANNESBURG

Carbon steel formerly used in this Simplicity aggregate drier wore out from smashing impact after handling 1¼ million tons of crushed dolomite but life expectancy is now over 4 million tons. Drier operates in one of the plants of The J. E. Baker Co.

Lukens "T-1" steel triples life of rock drier

TRADEMARK

Are impact and abrasion shortening the life and rocketing the costs of your equipment? If so, there's a lesson here for you:

When the liner shell and partition plates of this 10 x 20 foot Simplicity aggregate drier were replaced with Lukens "T-1" steel, life expectancy increased threefold!

Whether you handle stone, coal, or metal ores, it will pay you to investigate Lukens "T-1" steel for surfaces hard-hit by impact and abrasion. The 321 minimum Brinell quality has been known to outlast ordinary steels by 18 to 1. Applications are many throughout the materials handling and processing industries. Wear plates, chutes, hoppers, and mine cars are typical.

The remarkable combination of hardness and toughness in this high yield strength, readily welded alloy steel is even maintained at temperatures well below zero. *Send for informative illustrated booklet, "Lukens 'T-1' Steel." Write Manager, Marketing Service, Room 901. Lukens Steel Company, Coatesville, Pennsylvania.*

LUKENS ®

Helping industry choose steels that fit the job

CYANAMID

REAGENT NEWS

"ore-dressing ideas you can use"

For Silica Flotation or Slime Flocculation-- AEROMINE® 2026 Promoter

Originally developed and manufactured for Cyanamid's own Florida phosphate operations, AEROMINE 2026 Promoter is an economical silica or silicate flotation collector and is also valuable as a flocculant for fine clay slimes to improve settling and filtration rates.

At Cyanamid's phosphate operations, rougher concentrates floated with crude tall oil contain considerable silica. These concentrates are washed with dilute sulfuric acid to remove the fatty acid coating prior to the silica float. In the cleaner circuit, 0.2 pounds per ton of AEROMINE 2026 with 2.0 pounds per ton of kerosene are used to float off the silica.

As a flocculant at a non-metallic operation producing clay minerals, 0.3 to 0.5 pounds of AEROMINE 2026 per ton of dry solids improve the filtration rate of slimes as much as 35%.

Here are the properties of AEROMINE 2026 Promoter:

Color	– Dark brown
Consistency	– Viscous paste
Specific Gravity	– 0.96
Solubility	– Water-soluble–5% solutions recommended. Also soluble in kerosene and alcohol frothers.

For a sample of AEROMINE 2026 Promoter for trial in your own laboratory, fill in the coupon below.

Please send me a free sample of AEROMINE 2026 Promoter.

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MINING CHEMICALS DEPARTMENT

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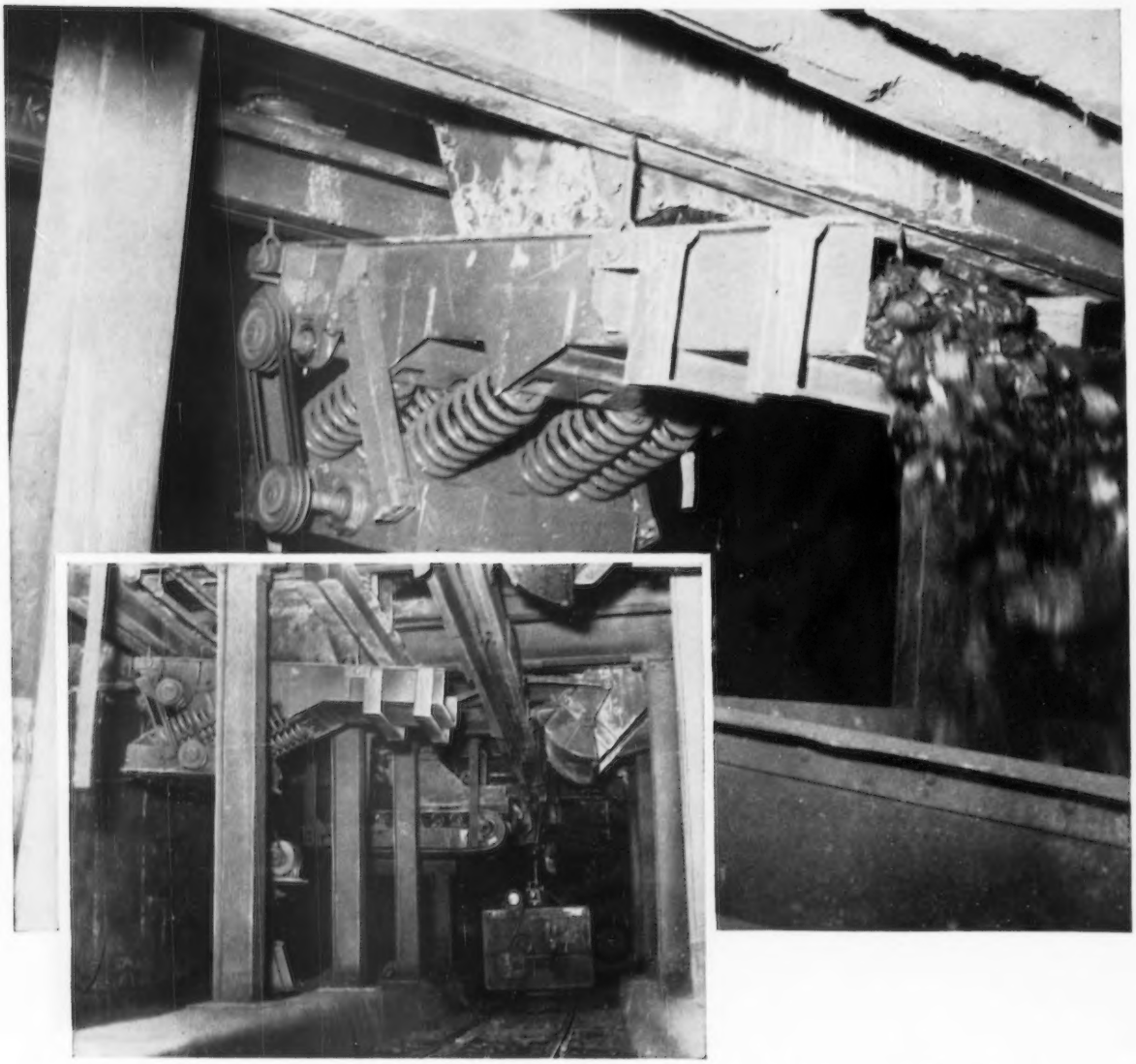


140 tons of ore per hour...with only 1 h.p.!

THIS Carrier Natural-Frequency Vibrating Feeder easily handles 140 to 150 tons of ore per hour with its 1 h.p. motor, because 90% of the power is supplied by rugged coil springs, utilizing Carrier's principle of "Natural Frequency." Most of the force required to compress the springs is returned when the spring expands.

Only 10% of the force required to vibrate the pan is transmitted through the bearings. This extremely low input-horsepower requirement, coupled with the elimination of large stress concentrations, guarantees low maintenance and less downtime.

Other design advantages of this Carrier unit include:

Mechanical Dependability—No complicated electrical system required. Simple mechanical drive system—unaffected by dust or magnetic particles.

Rugged Construction—Troughs fabricated of ¼" to 1"-thick steel plate, depending on width. Can be furnished with wear plates if desired.

Easy Installation—Natural-Frequency Feeders can be floor-supported or suspended from above.

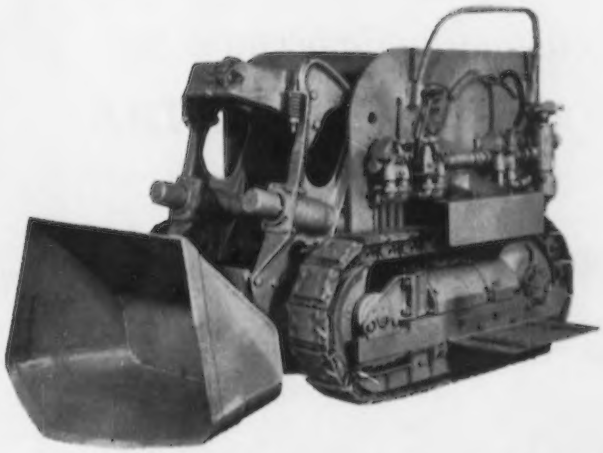
Greater Length—Standard feeders available in 6, 12 feet lengths, or greater if required.

Special Designs—Units may be designed with grizzly and screen decks for sizing, separating and dewatering. High-temperature units available for materials up to 2000°F.

Full details on the application of Carrier Conveyors and Feeders to your materials handling may be obtained by writing to: Carrier Conveyor Corporation, 215 No. Jackson Street, Louisville 2, Kentucky.

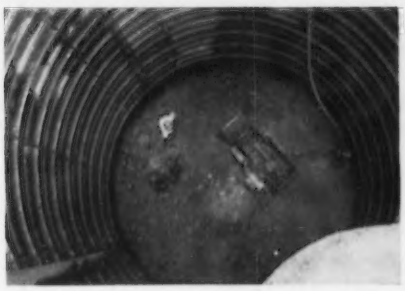
CARRIER
-NATURAL-FREQUENCY-
CONVEYORS

EIMCO 630's . . CUSTOM DESIGNED TO FIT YOUR JOB CONDITIONS



With half flat and half grouser track shoes, this Eimco 630 is equipped to crowd and maneuver efficiently in a narrow shaft. Two bulldog teeth guide the bucket directly into a muck pile . . an important factor in shaft mucking. Many special accessories permit Eimco to custom design 630's to fit your specific loading scheme.

The Eimco 630 now can be equipped with special "incline" rocker arms to give it the same excavating and loading efficiency on steep grades that is achieved by standard arms operating on the level. With complete data at their disposal, Eimco's Engineering Staff can recommend the rocker arm assembly most pofitable for you.



SHAFTS:

SAND TUNNELING:

Mining from draw points, open stopes or drifts -- in development or production work . . driving rock or running ground tunnels . . and various surface loading applications, EIMCO 630 TRACTOR-LOADERS muck for progressive firms seeking faster, more profitable excavating methods.

Eimco's willingness to evaluate new ideas suggested by members of the Mining Industry or developed from on-job surveys by Eimco Sales Engineers . . . has resulted in many precision "alternate" designs and accessories. These features -- when engineered into the basic Eimco 630 -- provide you with a "specialized" machine to handle the requirements of your particular job . . faster and more profitably.

SURFACE LOADING:

OPEN STOPES

THE EIMCO CORPORATION

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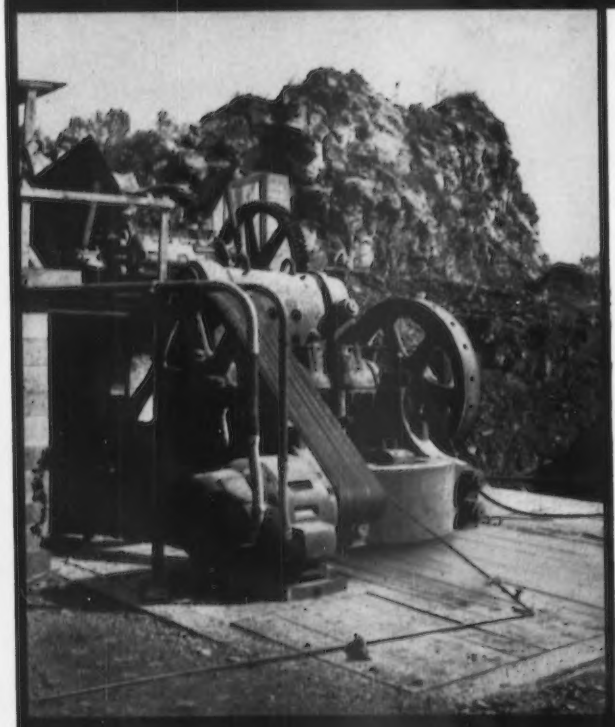
B-268

the big league ball player has his equipment custom-made because he gets something **EXTRA**



the profit-wise operator BUYS TRAYLOR JAW CRUSHERS for the same reason

For over a half century, producers have specified Traylor-made Jaw Crushers to insure extra hourly production with lower operating costs per ton. There are four types of Traylor-made Jaw Crushers to fit every primary breaking requirement. Feed openings range from 8″ x 12″ to 60″ x 84″; capacities from 4 to 1000 tons per hour. For bulletin on the Traylor Jaw Crushers best suited to your needs, write stating product size and capacity desired.

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Sales Offices: New York—Chicago—San Francisco
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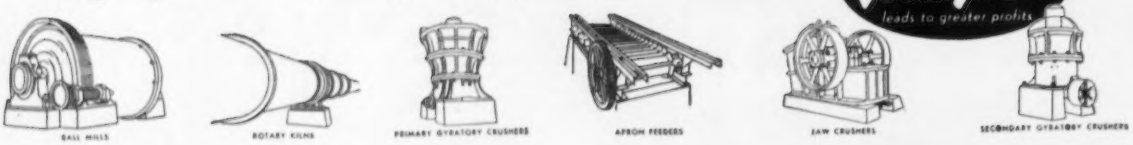
the experts agree . . . there's nothing like

TRAYLOR-MADE

equipment for peak performance

A Traylor leads to greater profits



If Your Filter Cakes Look Like **THIS**

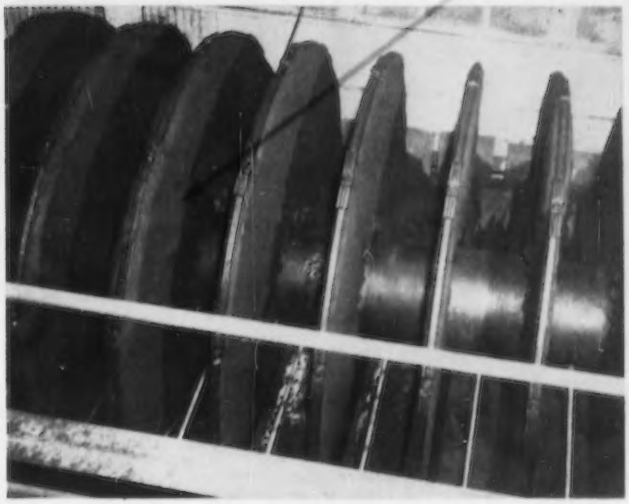
FROM IMPROPER AGITATION

Thin, slimy, uneven cakes exhibited by these discs result in LOW PRODUCTION, HIGH MOISTURE AND EXCESSIVE BAG COSTS. The main evil? IMPROPER AGITATION!

YOU'RE **PAYING** *FOR AN* **EIMCO AGIDISC**

WITHOUT GETTING ITS BENEFITS

PROPERLY DIRECTED AGITATION begins a chain of PROFITABLE results when you employ EIMCO AGIDISC. Uniform particle suspension promotes uniform, dry cakes . . . which in turn promote high capacity, low moisture, dependable operation and many other benefits.



Watching your production curve rise steadily is your assurance of greater returns from every $ you invest in Eimco equipment and in raw materials.

Check your equipment performance with an Eimco Sales Engineer. You can pay for a new Eimco Filter in a short time from increased profits and then realize the full economic benefits of MAXIMUM PRODUCTION at MINIMUM COSTS.

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EIMCO

B-269

They're Drilling Dolomitic Limestone In Eastern Missouri Lead Mine

The picture above, taken in a lead mine in southeastern Missouri, shows the positioning of a blast hole in medium-hard dolomitic limestone. The holes, made with Bethlehem Hollow Drill Steel, have an average depth of 10 ft.

In this lead belt, the ore bodies occur principally in the lower half of the Bonne Terre dolomite, which attains a thickness of nearly 400 ft. The stopes are horizontal and vary in height from 8 ft to 40 ft. Mining progresses by the room and pillar method, leaving open stopes. The 7/8 in. Bethlehem Hollow Drill Steel is used in jackhammers and jumbos equipped either with one-use steel bits or carbide-insert bits.

Bethlehem Hollow Drill Steel is a good performer in all kinds of rock drilling jobs because it is rolled from fatigue-resistant steel, and has a uniform, centrally located hole. Bethlehem Hollow also has a wide quenching range. It is easy steel to heat-treat for the proper balance of toughness and wear-resistance, making possible long-wearing threads and strong shanks.

Bethlehem Hollow Drill Steel is furnished in Carbon and Ultra-Alloy grades in rounds, hexagons and quarter-octagons. It comes regularly in lengths of from 18 ft to 27 ft, though longer lengths can also be supplied. Specify Bethlehem Hollow the next time you order drill steel.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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BETHLEHEM STEEL

65 belt hp!
up to 15,500 lb drawbar pull!
forward speeds from 1.5 to 5.5 mph!
reverse to 4.1 mph!

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HD-6

Tractor-Dozer

MORE POWER—BETTER DOZING SPEEDS—BIG-DOZER DESIGN—NEW HANDLING EASE!

Only dozer of its size with these basic advantages . . . engine-mounted rams, long push beams, fewer linkage points (only 2 instead of 5 or 6). These big-dozer features all combine to provide more accurate, gouge-free dozing . . . longer equipment life.

Convenient rotary-valve blade control makes the HD-6 the easiest handling dozer of its size. With more than 5½ feet of track on the ground, it has outstanding flotation . . . yet turns easily in any terrain. The HD-6 also combines large, low-set front idlers with a blade snugged close to the radiator guard . . . to provide balance that means better dozing, more work done under any conditions!

You can <u>see</u> it . . . but there's only one way to <u>prove</u> it—on **your** job!

Illustration from Agricola's De Re Metallica (1621)

Special attention was necessary

In olden days, every piece of ore presented special problems for the processor. It had to be handled separately . . . carefully placed under a clumsy stamp . . . and slowly crushed bit by bit.

Today, it is just the opposite. Modern plants produce a never-ending stream of properly sized ore. For they have efficient grinding mills that often use CF&I Grinding Balls and Rods. Always made of special analysis steel that has an ideal balance between toughness and hardness, CF&I Grinding Balls and Rods combine optimum grinding ability with maximum wearability.

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Gentlemen:

Please have the Allis-Chalmers construction machinery dealer serving my area arrange a demonstration of the HD-6 tractor-dozer for me.

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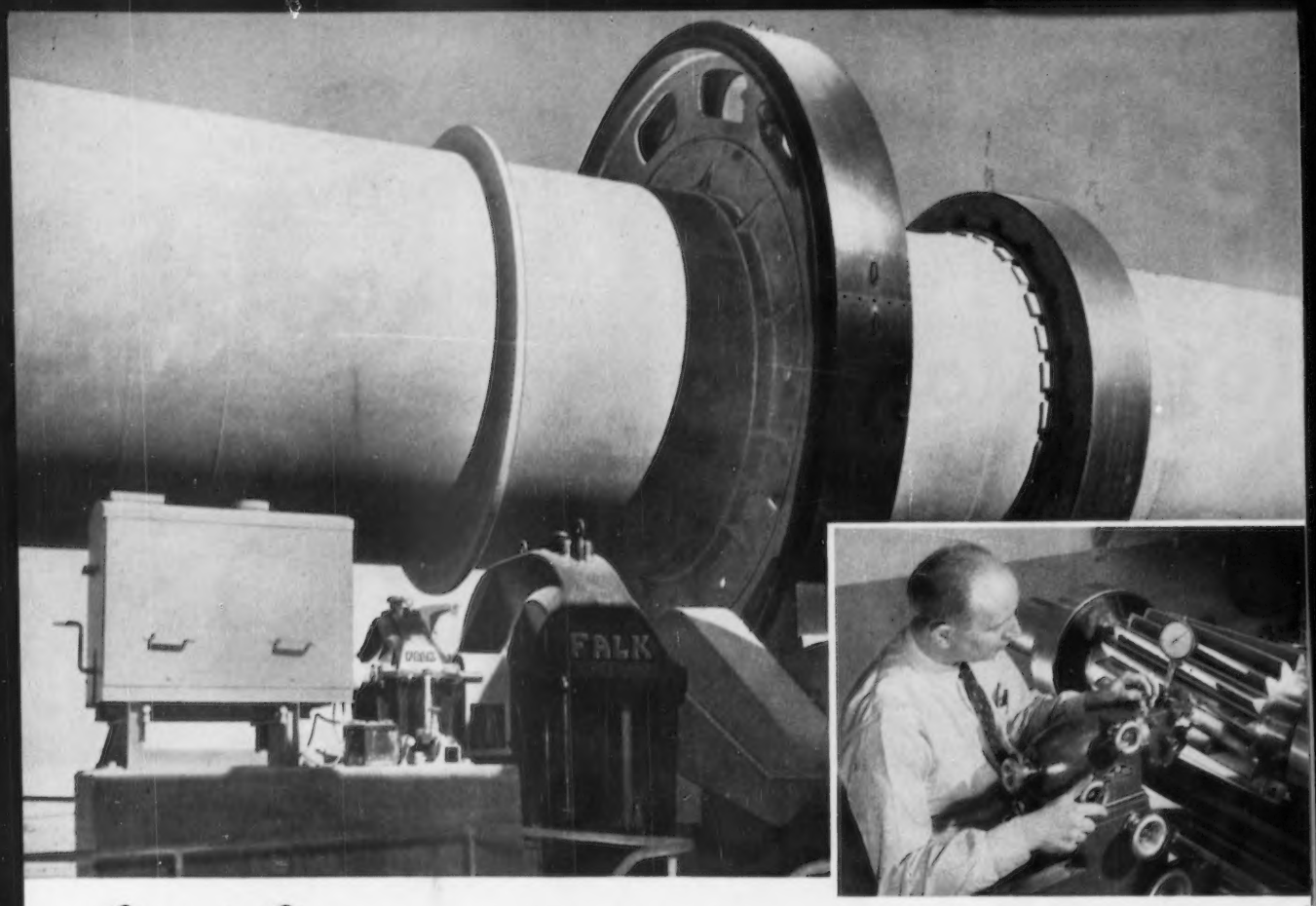

Quick Quiz on Gear Costs

—plus some money-saving answers!

Here are some questions and answers of major importance to mill and kiln operators and engineers who want to keep costs down:

Q. Are you losing production through "down time" caused by gear failures and frequent pinion replacements?

A. Falk Helical Gears and Pinions, correctly engineered, precision-hobbed and of highest efficiency, *keep operating* year-in-and-year-out.

Q. Do antiquated gears force you to use large, costly, slow-speed motors?

A. Falk Helical Gears provide a single-mesh, high reduction ratio drive which permits use of higher-speed motors resulting in savings in power bills and space.

Q. Is abrasion causing accelerated wear on your spur gears and shortening their life?

A. Falk Helical Gears are specially designed and precision-built to give maximum resistance against abrasive wear.

Q. Are gear teeth of outmoded design being taxed beyond their capacity?

A. In Falk Helical Gears, with full depth profiles, several teeth share the load at all times, assuring long service life.

Q. Is vibration, caused by inaccurate gearing, damaging associated equipment?

A. Falk Helical Gears operate so smoothly that vibration resulting from tooth contacts is eliminated.

When expanding or modernizing your mill or kiln facilities, you can effect substantial long-range savings by specifying "Helical Gears by Falk," the nation's pioneer and largest supplier of precision, helical gearing.

Consult any Falk Representative—also, write for
Engineering Report 6170, "Advantages of Helical Gearing"

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MANUFACTURING TECHNIQUES THAT BENEFIT GEAR USERS

The manufacture of Falk Helical Gears and Pinions involves many unique and interesting techniques in foundry, machine shop, laboratory, gear cutting and other departments—including inspection.

A typical example of the extreme thoroughness of Falk methods is shown in the small photograph above. In the Falk gear laboratory, the correctness of tooth spacing on a mill pinion is determined by measuring the normal base pitch. Readings are taken completely around the pinion. Tooth-to-tooth spacing is generally within limits of .0002", and total accumulated spacing error averages only about .0005". These values are a natural consequence of the inherent accuracy of the machines and procedures employed.

Such techniques as this assure the gear user that he is receiving the utmost in quality in every Falk product.

FALK

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Crushing Iron Ore in South America with TELSMITH® Equipment

Telsmith 5′ x 12′ Heavy-Duty Scalper and 489S Gyrasphere Crusher.

Telsmith 25″ x 36″ Jaw Crusher and 36″x10′ Heavy-Duty Apron Feeder.

Telsmith 5′ x 12′ Heavy-Duty Finishing Screen.

• Acerias Paz de Rio, S. A.—the only steel mill in Columbia—owns this Telsmith iron ore crushing-screening plant. From the mines at Paz de Rio, the crushed ore is transported 30 miles to the steel mill at Belencito, 180 miles from Bogata. This Telsmith designed and completely Telsmith equipped plant crushes and screens 2500 tons per 8-hour day, of colitic limestone containing 48% iron. Get descriptive Bulletin 266.

TELSMITH

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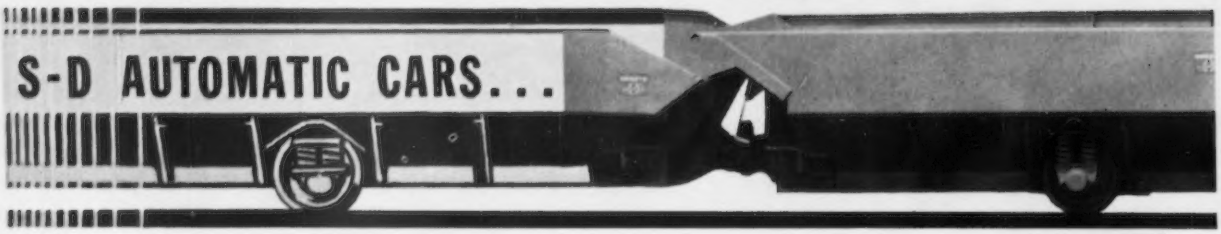
Another mine car development by Sanford-Day...

S-D AUTOMATIC CARS...

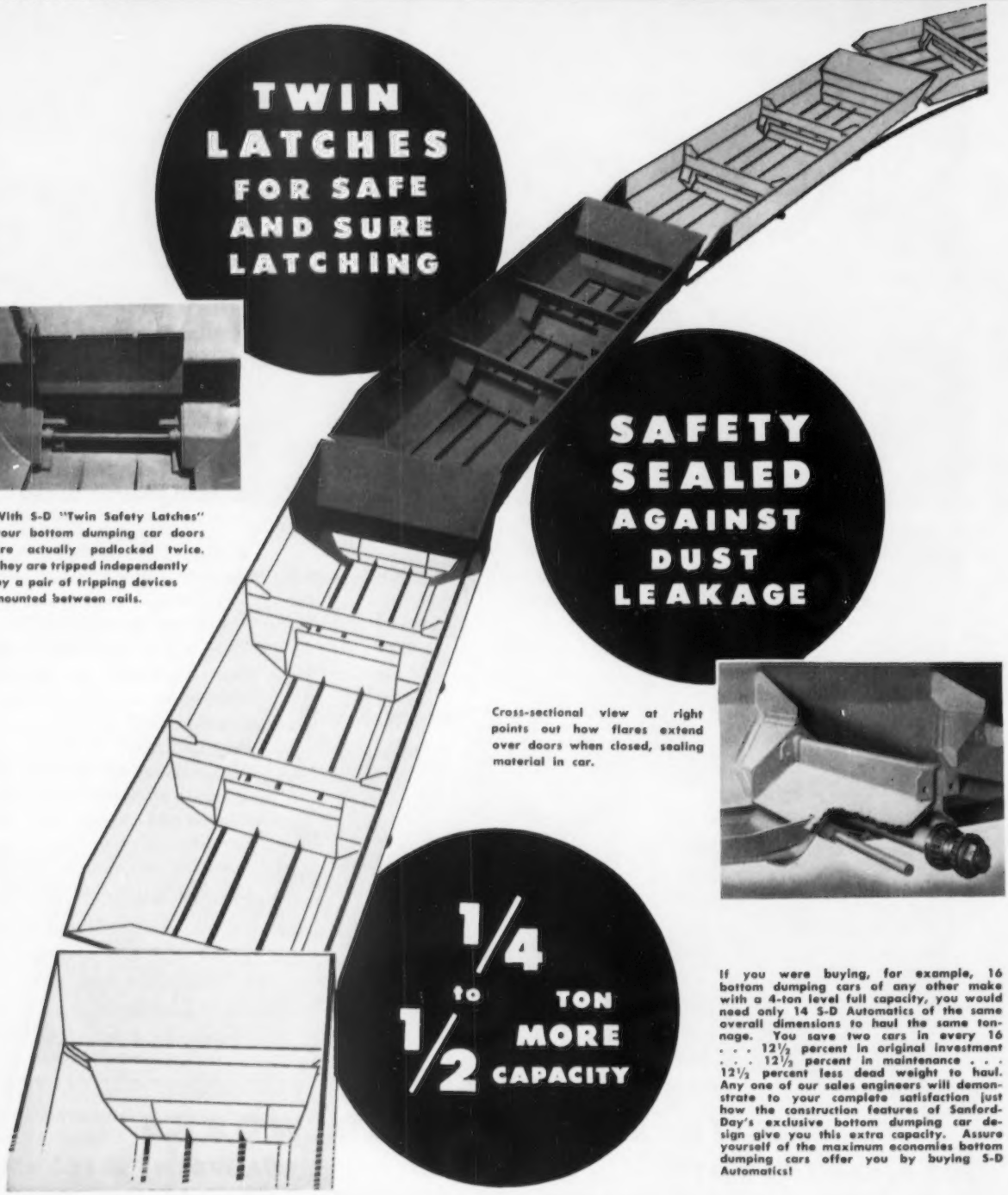


TWIN LATCHES FOR SAFE AND SURE LATCHING

With S-D "Twin Safety Latches" your bottom dumping car doors are actually padlocked twice. They are tripped independently by a pair of tripping devices mounted between rails.

SAFETY SEALED AGAINST DUST LEAKAGE

Cross-sectional view at right points out how flares extend over doors when closed, sealing material in car.



1/4 to 1/2 TON MORE CAPACITY

If you were buying, for example, 16 bottom dumping cars of any other make with a 4-ton level full capacity, you would need only 14 S-D Automatics of the same overall dimensions to haul the same tonnage. You save two cars in every 16 . . . 12½ percent in original investment . . . 12½ percent in maintenance . . . 12½ percent less dead weight to haul. Any one of our sales engineers will demonstrate to your complete satisfaction just how the construction features of Sanford-Day's exclusive bottom dumping car design give you this extra capacity. Assure yourself of the maximum economies bottom dumping cars offer you by buying S-D Automatics!

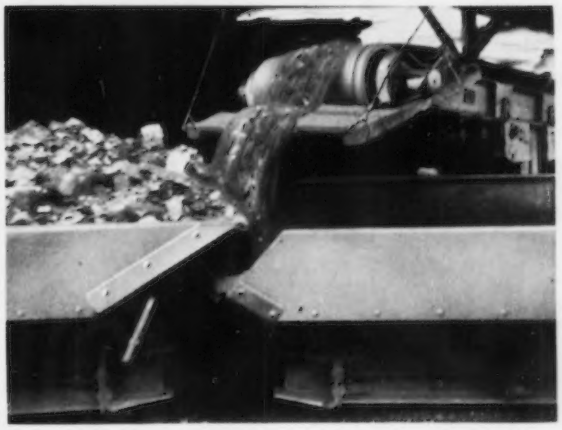
WITH OVERLAPPING ENDS

Now available in S-D Automatics only 32″ high!

To meet today's mechanization trends the S-D "Automatic" bottom dumping mine car with *overlapping ends* provides the ideal, practical answer to the question, "How can we obtain continuous loading of trips at loading points?"

In addition to others and the S-D "Automatic" illustrated, we recently manufactured and shipped to a Kentucky mining company the same design car, but only 32″ high, 6′8″ in width, 19′ center-to-center of couplers and having an inside body length of 16′. In addition to *overlapping ends*, you also obtain in S-D "Automatics," and only in S-D "Automatics": 1 — "Twin Safety Latches" for safe and sure latching . . . 2 — Cars that are Safety Sealed against dust leakage, and 3 — ¼ to ½ ton more capacity per car for the same overall dimensions! Write us today for complete information! *Sanford-Day Iron Works, Inc., Knoxville, Tennessee.*

Pictured below is a trip of S-D "Automatics" with Overlapping Ends in actual operation. The car above (and further illustrated at right and left) is one recently ordered by a large company. It is 7′ in width, 44″ high, 20′ center-to-center of couplers with an inside body length of 16½ feet. It further features spring mounted trucks and automatic couplers.



SANFORD-DAY

Knoxville, Tennessee

HIGH IN

P&H

ELECTRICS

ARE WORKING FOR SOUTHERN PERU COPPER

In their operations as high as 13000 feet in the Peruvian Andes at Toquepala, Peru, Southern Peru Copper is using P&H Electric Shovels. Their maximum availability and minimum maintenance are vital to high production. In addition to 10 P&H Model 1800 machines, Southern Peru Copper has purchased 23 P&H diesel powered excavators.

Only P&H Electric Shovels have these outstanding exclusive features.

MAGNETORQUE®. . . the electro-magnetic type coupling that transmits power from the hoist motor to the dipper for faster action, eliminating shock and impact to the hoist gear train and motor. Response is immediate to varying load conditions.

ELECTRONIC CONTROLS . . . providing the fastest action of any type of control available on electric shovels. All motions are smoother, resulting in consistently higher output.

Whether it's big P&H Electric Shovels from 3½ through 8 cu. yds., or smaller P&H excavators, it will pay you to choose from the P&H complete line. P&H offers single source responsibility for all your open pit mining needs.

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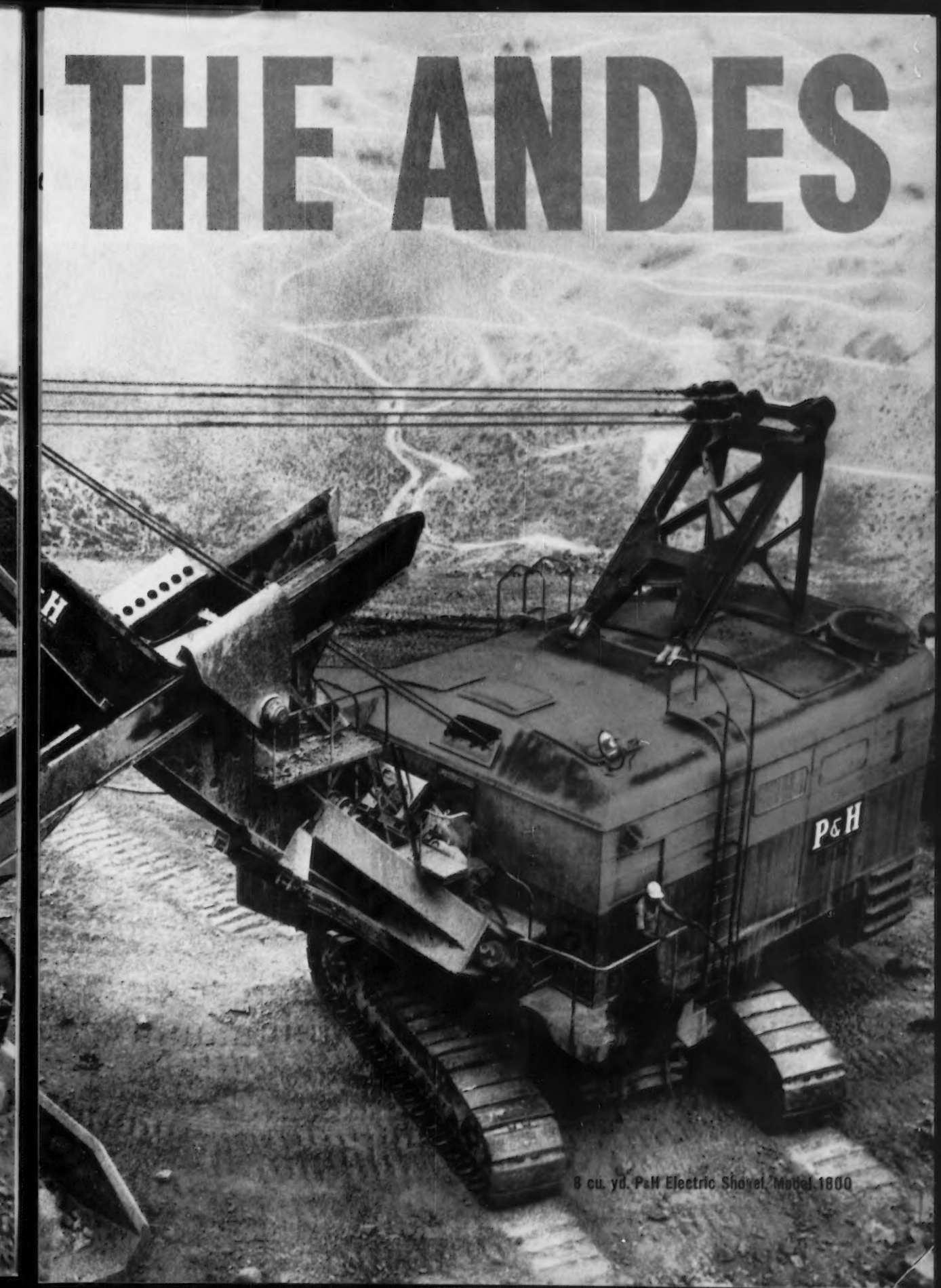
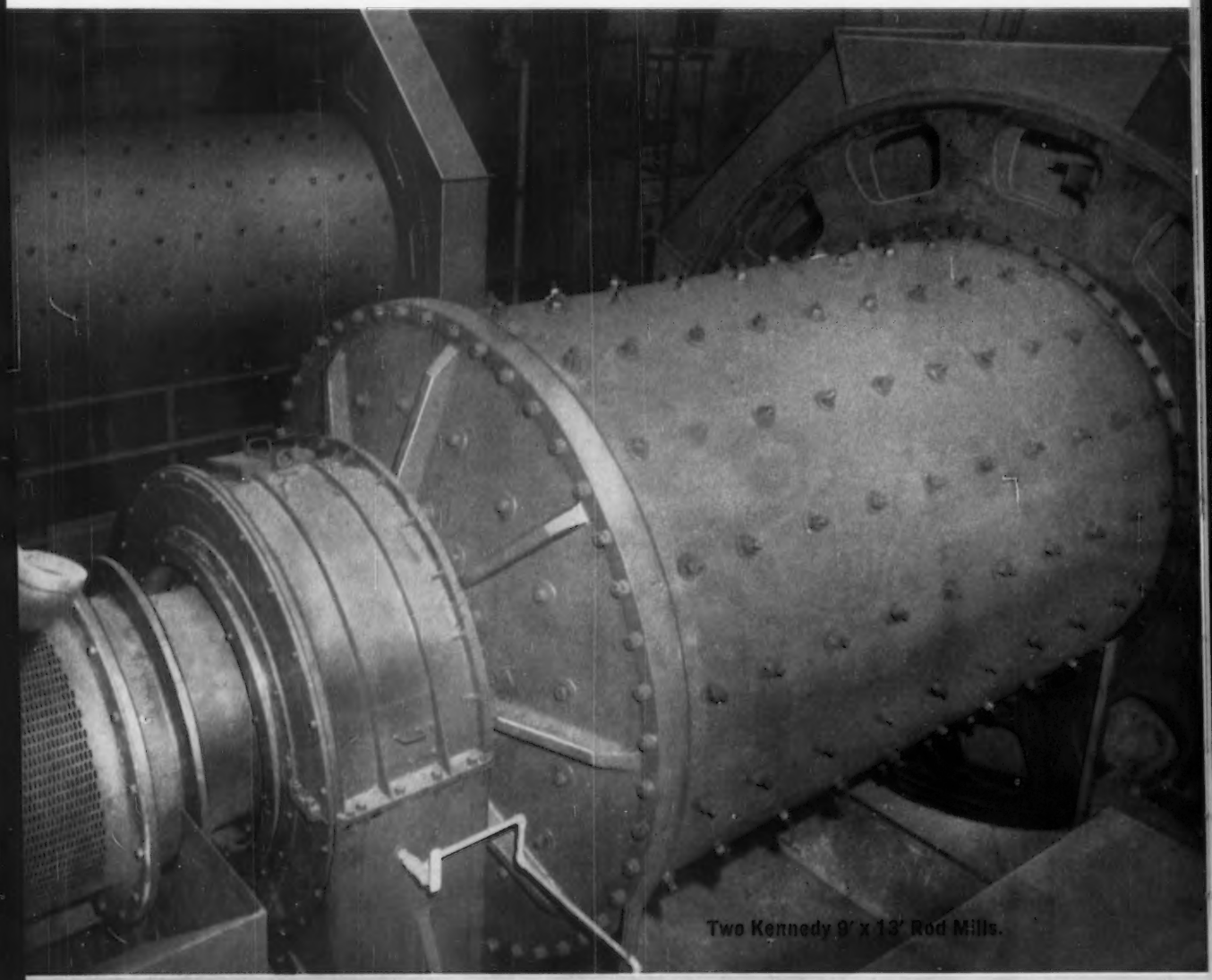
THE ANDES



8 cu. yd. P&H Electric Shovel, Model 1800

KENNEDY ROD MILLS

Now in Operation



Two Kennedy 9' x 13' Rod Mills.

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★ Cast Steel or Meehanite Heads ★ Welded and Stress-relieved Shells

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★ Positive Ferris Wheel lubrication for main bearings with oil-tight seals

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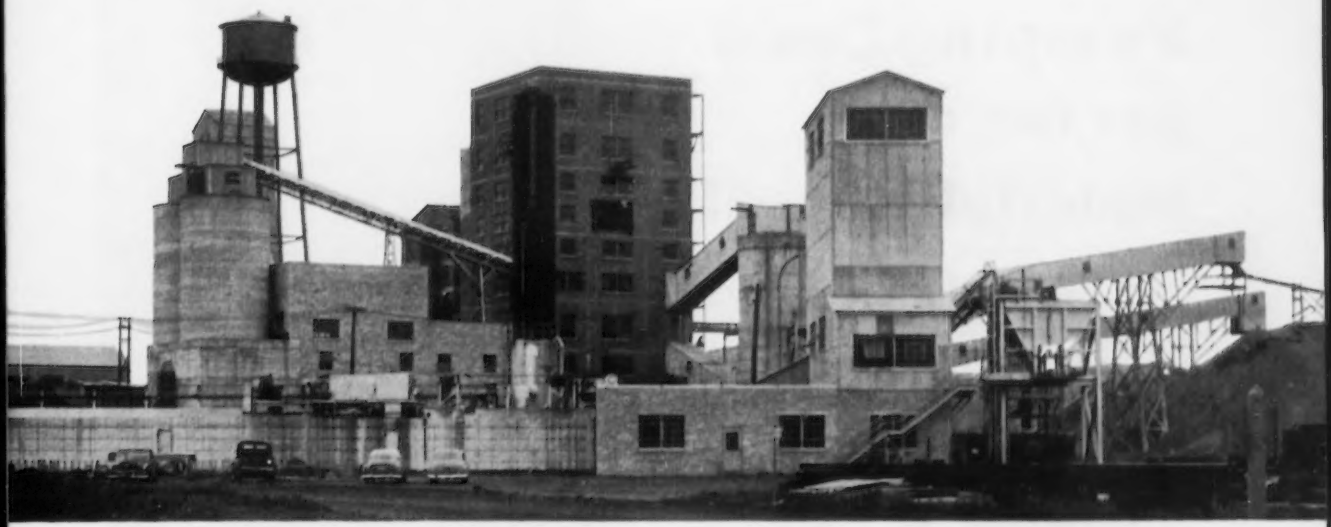
Let our Engineering Department furnish data on any size mill for wet or dry grinding—

FOR GRINDING IRON ORE

at SHAHMOON INDUSTRIES

Shahmoon Industries use Kennedy Swing Jaw Crushers, Rod Mills, Rock Feeders and Conveyors to crush, grind and transport ore.

Kennedy equipment was chosen on a basis of proven performance, peak capacities and lowest maintenance and power costs. Our engineers are available for consultation on any problems relating to the handling and crushing of all types of rock and ore.



KENNEDY PRODUCTS

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- Swing Jaw Crushers
- Tube Mills
- Ball & Rod Mills
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- Rock Feeders
- Air Swept Tube Mills
- Rotary Kilns
- Coolers, Dryers
- Preheaters, Deheaters
- Belts, Conveyors
- Pneumatic Transport Systems
- Asbestos Plants
- Complete Lime Plants
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ENGINEERING AND MINING JOURNAL

JULY 1957

"Travel Light and Be Ready to Jump!"

IT'S ALWAYS EXCITING to read about technical or scientific breakthroughs that promise to revolutionize some field or other. The transistor is a good example. Its development sent the whole electronics industry scurrying for a fast education in solid-state physics—a science so new that no comprehensive textbooks existed on the subject when transistors were discovered. The result of this new discovery was a rash of diminutive gadgets such as the pocket radio and the cordless hearing aid, and of course a fancy price for the hitherto obscure metal germanium. Now, close on the heels of the transistor comes the solion, an electrochemical device which promises to outdo both the transistor and the electronic tube in certain applications. And so the poor electronics engineers' hopes for technological tranquility get shattered again.

But in our observations of the fascinating Buck Rogers developments in other fields, let's not be complacent about mining. We appear to be in for some technological breakthroughs that could rock conventional patterns which have prevailed for decades. It now appears possible that the blast furnace could be by-passed in steel making, and that an ore-to-metal reduction unit could be tacked on to the tail end of a taconite concentrator or other beneficiation flowsheet to produce some form of steel directly by new methods being patented here and abroad. Just to satisfy yourself on that score, keep an eye on some of the patents that *E&MJ* reports each month in its regular New Patents column.

Certain hydrometallurgical processes are being outmoded almost as fast as they receive commercial application. Solvent extraction for instance, which is old as the hills as a laboratory technique, now competes vigorously with ion-exchange methods which only a few years were in the hush-hush stage of new development.

Even the transit, the traditional stand-by of the mining engineer, is in for replacement—at least in triangulation and map making. The newcomer is the tellurometer, an electronic device that measures the distance between two given points within line of sight. Distance is determined by clocking microwaves traveling from a master station to a remote station and back. Error of the new system is said to be only about three parts in 1-million. Canada's Department of Mines and Technical Surveys intends to use six of these devices and save something like $100,000 in survey costs this year as a result.

Up until the time of World War II, use patterns of metals changed slowly. But since World War II, research has threatened to stir up applications of conventional materials considerably. For instance, iron, nickel and cobalt were formerly basic materials for magnets. Then the solid-state physicists found out what makes a magnet, and today some of the world's strongest magnets are made from such materials as bismuth, manganese and even non-metallics. We hesitate to guess what might happen to copper or aluminum if some bright physicist finds out what makes a conductor.

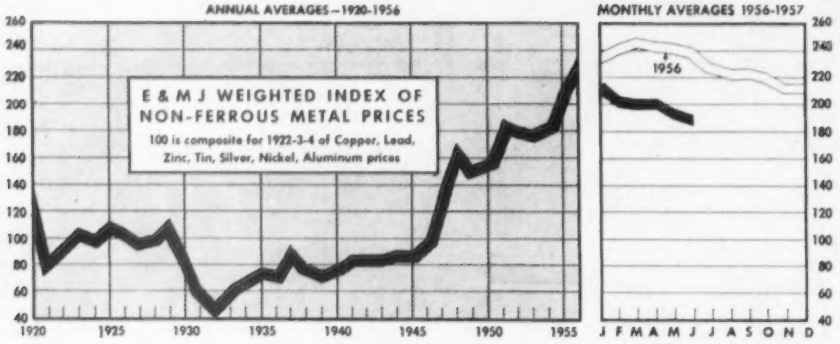
One of the most important breakthroughs ever made in glass research has yielded Pyroceram, which can be made harder than steel or granite and will probably cost less than glass or steel. The only way for metal producers to stay on top of this kind of a situation is to allocate a penny or fraction per pound of metal income to develop new uses.

If you review the progress of mining during the past ten or twelve years, you will realize that the industry has undergone a technological renaissance unprecedented in history. Such developments as jet piercing, the airborne magnetometer, tungsten-carbide drilling, cyclone classification, solvent extraction, hydrogen-reduction methods, etc., show that more progress has been made in the past decade than in the previous fifty years or more. So we have had our own industry technological breakthroughs—and the end is nowhere near in sight. If anything, the pace may be accelerating because research techniques have been stepped up with electronic calculators and other modern tools.

Maybe we'll all have to follow the advice of the successful old-timer who told his protégé to "travel light and to be ready to jump!"

E&MJ OUTLOOK

PRICES



MARKETS

Sharp cuts in copper, lead and zinc prices trimmed E&MJ's metal price index downward from 198.69 (revised) for May to 191.93 for June. Silver and tin were also lower for the month.

Further slashes in base metal prices are being resisted by means of mine shutdowns, shorter work weeks and curtailed smelter production designed to bring supply more in line with current demand. Industry appears to be taking steps to set its own house in order rather than depending upon Government aid, support or relief. Recent scuttling of the domestic tungsten program has shown how capricious Government support can be.

•

AT HOME

Vanadium Corp., veteran Plateau uranium producer, is now pushing exploration work in the Grants, N. M., district.

Naval Ordnance Laboratory has developed a new electrochemical device that may rival the transistor and vacuum tube in the electronics field.

Gas turbines developed by Westinghouse and General Electric are showing a wider application potential than any other type of prime mover yet developed. Utilities find these units ideal to generate low-cost power for peak loads.

The current lull in metal demands is causing some mining companies to "stretch out" programs for new property development and construction.

"Tight money" is causing some manufacturing plants to cut metal inventories—some as much as 15%.

Uranium Reduction Co. has effected prepayment of a $3½-million loan from Chemical Corn Exchange Bank of New York. The company's 1,500-ton mill has been running at higher than its rated capacity since its start up in late 1956.

•

LABOR

Mine-Mill's traditional opposition to tariffs is being reversed. High imports and low metal prices has induced the union to join Western mine operators in demanding metal import control measures. See p 121.

•

ABROAD

Canada's Department of Mines and Technical Surveys is adopting a new electronic unit called the tellurometer which measures microwave travel time between sender and pick-up to determine survey distances accurately. Six machines purchased are expected to save at least $100,000 in survey costs this year.

Mine and government officials predict that exploration will reach record proportions this year in northern Saskatchewan's Lac la Ronge region, 170 miles north of Prince Albert.

Baffin Island's government is trying to court venture capital for development of extensive local iron deposits. It's competing with Quebec's Duplessis.

Now that venture mining capital is getting tighter, several Central and Latin American republics are preening their mining codes to vie with Peru's attractive climate for foreign investors.

MARKETS

Copper, Lead, Zinc Prices Fall; Aluminum Soft, Price Rise Possible

NON-FERROUS METAL PRICES dropped 3½% in June. The *E&MJ* non-ferrous metal price index is 191.42; the May index was 198.69. Price drops for copper, lead and zinc contributed to the fall. Copper dropped nearly 1c; the May average was 31.288c per lb; the June average 30.334c. Lead dropped from 15.385 to 14.32c and zinc dropped from 11.923c per lb to 10.86c. A drop in silver from 98.409c per oz to 98.06c had some affect.

Average metal prices are expected to be lower in July when the full effect of present low prices will be apparent.

Long term mineral program chances are uncertain though observers feel there is little chance of passage. Interior Department proposed zinc ore import duties published here last month have been revised. Under plan (B) when the zinc price is 13½ to 14½c the duty will be 0.4c rather than 0.6c and when the price is 12½ to 13½c the ore duty would be 1.1c rather than 1.2c.

Producer copper prices in the U. S. dropped to 29¼c a lb delivered. Phelps Dodge took the lead June 19; Kennecott followed soon after; most other producers were at the new price before the day was over. Noranda and International Nickel dropped to 27⅞c Canadian currency. Anaconda went to the new price June 20.

Most factors had expected the price to drop to 30c. Some say one of the major reasons 29¼c was selected was that if 30c had been the new price custom smelters would probably have gone to 29c anyway and the 1c margin would have interfered with producer sales. With the fractional price they suggested smelters were not so likely to cut lower. But many analysts believe this was a minor determinant and that other matters were much more significant. They point out that avoidance of fractional prices is not a habit of smelters. They say the smelters will have to move their copper and if they cannot continue to sell more copper, relative to producer sales, than when the market was stronger, they will drop the price below the 29c level (smelters dropped to 28½c).

RST companies on Monday, June 17, cut their price to U. K. customers to £230, about 28½c a lb. This was about 1½c above LME prompt bid at the end of the month. July 1 RST went to £220, about 27.4c at current exchange rates. The LME dropped to £215¾, ½c below RST. Many analysts believe the RST price can be maintained ½c above LME, but a greater margin can not persist. Katanga went to 28.95c (Europe) June 20; the margin over RST and LME is not likely to last.

U. S. fabricator prices and custom smelter scrap buying prices came down as the other U. S. prices dropped.

Price agreement by the two Rhodesian copper producers will be discussed by U. K. fabricators at a meeting July 3. Reports are RST customers favor the proposal and Oppenheimer customers are opposed. The new proposal, some feel, would make trading operations difficult for firms that do a trading business in addition to fabricating. Hedging on the metal exchanges would also be more difficult, some believe.

Production cuts mount. Anaconda will reduce operations from 6 days to 5 at Yerington—this means about 416 tpm less copper. Added to the earlier cuts, including 500 tpm by Howe Sound, 800 tpm by Miami and 500 tpm by Inspiration Consolidated Copper, the U. S. reduction is about 6,500 tpm. But some of the newer mines may be in a stage of development in which they must expand output in order to reduce average costs. Their overhead costs especially may be based on a higher output.

Copper statistics were bad. Copper Institute data show May producer stocks rising sharply in the U. S. and outside the U. S. no significant drop. Copper fabricator data for the U. S. show fabricator stocks of copper up in May. Shipments of products were down from April. During the five months of 1957 fabricator shipments totaled 572,000 tons; for the corresponding period of 1956 it was 646,000 tons. Sales in May were better than in April but still not good.

Some accelerated buying occurred in France as fear of devaluation caused some to get out of money into copper. But some earlier credit restrictions on forward buying, and later additional restrictions, made for some uncertainty of French metal buying.

Lead dropped to 14c N. Y. June 14; a custom smelter took the lead. London lead had been 3¾c below N. Y. Lead had been selling (by dealers) in the U. S. at ½c and more under the regular price; some discount selling was based on the *E&MJ* price and some at flat prices. The lead drop reflects poor markets, virtual stoppage of barter and uncertainty about future Government buying. In May and June the Government bought more lead and zinc (than earlier) for the stockpile from domestic sources—this is considered an attempt by the Government to maintain prices and to some extent may reflect pressure from Western political groups.

London lead prices dropped following the price cut in the U. S. by about ¼c. Some regard this small drop as encouraging. But the margin of about 2¾c is large enough to maintain heavy imports into the U. S. The strike at the AS&R Monterrey, Mexico, lead plant (12,000 tpm) that began May 27 may reduce imports somewhat. A number of U. S. Government agencies, including the Tariff Commission, the House Ways and Means Committee and probably the State Department now are reported inclined to the view the higher tariffs in the Interior's mineral program would be inconsistent with our agreements under GATT. May U. S. lead statistics show shipments to industry low and shipments to Government high.

Zinc prices continued to fall. On July 1 a smelter dropped zinc to 10c East St. Louis—other sellers followed. Zinc in London was about 9¼c; a week earlier it was about 8.8c. On June 19 a smelter cut to 10½c. June 6 a smelter had cut to 11c. The Ft. Smith and the Dumas, Texas (both use American Zinc's concentrates) announced output cuts of about 1,500 tpm. AS&R is reducing zinc metal output by 5,700 tpm; of this 2,700 tpm will be Special High Grade at the Corpus Christie plant—this will be zinc ordinarily refined from zinc fume from the firm's zinc smelter at Chihuahua, Mexico. Other zinc producers are likely to cut output soon.

Late in June the Government accepted about a third more domestically mined zinc than in May; in May it took about 10% more than in earlier months. But no one is "doing anything" for foreign zinc, including that smelted in the U. S. and the present zinc import duty and the less than 1c freight cost (for most imported zinc) is not enough to keep the U. S. market for U. S. miners. Peru, Canada, Australia and Mexico and possibly other countries have protested the proposal to raise U. S. import duties on zinc and lead. These countries import many things (especially machinery) from the U. S. and in so far as their dollar earnings from sale of metals to the U. S. drop, their imports from the U. S. are likely to drop.

Aluminum markets continue soft. Several large producers have pushed further into the future their expansion schedule. But primary prices may be raised when automatic wage hikes of about 7% go into effect August 1. Steel has the policy of raising prices each time wages rise, whatever the market situation. Aluminum is in the process of establishing this policy. Assuming wages are 50% of total costs and other costs do not rise now, the 7% wage and salary rise is a cost advance of about 3½%. A price rise of 1c for pig would be about a 4% increase, just cover the cost jump. But since 1939 the rate of aluminum price rise has been only about ⅓ as fast as the wage rate rise. But other costs have also been rising. There seems no way by which an upward wage-price spiral can be prevented; almost no one believes technological innovations can come quickly enough to offset the speed of wage increases in tightly organized industries.

Primary aluminum output in May, 1957 was 144,789 tons; April was 138,728 tons. May, 1956 was 150,800 tons. Alcan's Arvida plants remain on strike—they normally produce about 1,000 tpd.

MARKETS (*Continued*)

Average Prices June (*E&MJ* Quotations)

Copper:	
Electrolytic, domestic refinery	30.334
Electrolytic, export refinery	28.410
Lead:	
Common, New York	14.320
Common, St. Louis	14.120
Silver and sterling exchange:	
Silver, New York, per oz.	90.456
Silver, London, pence per oz.	78.283
Sterling Exchange	279.024
Zinc:	
Prime Western, East St. Louis	10.860
Prime, Western, delivered (g)	11.360
Tin:	
New York Straits	98.060
Gold per oz. U. S. price	$35.000
Quicksilver, per flask	$255.000
Antimony, (*E&MJ*)(d)	36.590
Antimony, bulk, Laredo	33.000
Antimony, in cases, Laredo	33.500
Platinum, refined, per oz.	$92.000
Cadmium (a)	170.000
Cadmium (b)	170.000
Cadmium (c)	170.000
Aluminum, 99% plus ingot	27.100
Magnesium, ingot	35.250
Nickel (f)	74.000

Domestic quotations, unless otherwise stated, are in cents per pound. Sterling exchange checks, in cents. Quicksilver, per flask of 76 lb.

(a) Cadmium average based on the producers' quotations.

(b) Cadmium average based on the average of the producers' and platers' quotation.

(c) Cadmium average based on platers' quotation.

(d) Domestic, 5 tons or more but less than carload lots, packed in case f.o.b. New York.

(e) Tin content.

(f) Contract price, f.o.b. Port Colborne, U.S. duty included. Other regular sellers 78¼¢ to $1.25.

(g) Delivered where freight exceeds 0.5c.

"Free" Gold Market

Trading declined 16½% during June. Coin prices dipped. European dealings were quiet, London leading. Demand for coins and gold remained high in the Satellite countries. No Soviet gold sales were reported from Europe. Asiatic markets showed lower prices. Central and South American trading was quiet with Brazil listing the world's lowest gold price, $33.75 per oz. Pick's World Currency Report quotes on "free gold" per fine oz as follows:

	COINS		BARS (12.5 kg)	
	May 31	June 30	May 31	June 30
NEW YORK, transit	....	.....	$35.08	$35.08
MANILA	$43.75	$43.75	36.50	36.20
HONG KONG	44.10	44.60	38.30	38.10
BOMBAY	59.75	55.75	59.00	54.75
TANGIER	42.75	42.90	34.92	34.90
BEYROUTH	43.30	43.00	35.04	35.15
PARIS	46.90	44.50	36.45	36.20
BUENOS AIRES	39.00	39.25	35.50	35.15

Note: Prices are quoted at the free or black market value of the U. S. dollar in the local markets.

Major Metals

U. S. DAILY AND AVERAGE PRICES

June 1957	Electrolytic Copper (a) Domestic	(b) Export	Lead New York	Lead St. Louis	Zinc (f) Delivered	Zinc East St. Louis	Aluminum Primary Pig 99%	Straits Tin New York
1	No Market	29.000	15.000	14.800	12.000	11.500	25.000	98.625
3	31.400	29.275	15.000	14.800	12.000	11.500	25.000	98.500
4	31.275	29.075	15.000	14.800	11.500	11.000	25.000	98.375
5	31.525	29.300	15.000	14.800	11.500	11.000	25.000	98.500
6	31.500	29.100	15.000	14.800	11.500	11.000	25.000	98.375
7	31.375	29.200	15.000	14.800	11.500	11.000	25.000	98.500
8	No Market	29.200	15.000	14.800	11.500	11.000	25.000	98.500
10	31.375	28.625	15.000	14.800	11.500	11.000	25.000	98.375
11	31.400	29.075	14.000	13.800	11.500	11.000	25.000	98.250
12	31.200	29.000	14.000	13.800	11.500	11.000	25.000	98.250
13	31.025	28.900	14.000	13.800	11.500	11.000	25.000	98.500
14	31.450	28.975	14.000	13.800	11.500	11.000	25.000	98.375
15	No Market	28.975	14.000	13.800	11.500	11.000	25.000	98.375
17	31.100	28.775	14.000	13.800	11.500	11.000	25.000	98.250
18	31.150	28.350	14.000	13.800	11.500	11.000	25.000	98.250
19	29.050	28.400	14.000	13.800	11.500	11.000	25.000	98.250
20	28.825	27.400	14.000	13.800	11.000	10.500	25.000	97.750
21	28.850	27.500	14.000	13.800	11.000	10.500	25.000	97.750
22	No Market	27.500	14.000	13.800	11.000	10.500	25.000	97.750
24	28.850	27.175	14.000	13.800	11.000	10.500	25.000	97.625
25	28.825	27.350	14.000	13.800	11.000	10.500	25.000	97.500
26	28.850	27.325	14.000	13.800	11.000	10.500	25.000	97.375
27	28.825	27.525	14.000	13.800	11.000	10.500	25.000	97.000
28	28.825	27.625	14.000	13.800	11.000	10.500	25.000	97.250
29	No Market	27.625	14.000	13.800	11.000	10.500	25.000	97.250
AVERAGES FOR MONTH								
June	30.334	28.410	14.320	14.120	11.360	10.860	25.000	98.060
AVERAGES FOR WEEK								
June								
5	31.363	29.067	15.000	14.800	11.800	11.300	25.000	98.525
12	31.370	29.033	14.667	14.467	11.500	11.000	25.000	98.375
19	30.755	28.729	14.000	13.800	11.500	11.000	25.000	98.333
26	28.840	27.375	14.000	13.800	11.000	10.500	25.000	97.625
CALENDAR WEEK AVERAGES								
June								
1	31.275	28.996	15.000	14.800	12.000	11.500	25.000	98.500
8	31.415	29.192	15.000	14.800	11.583	11.083	25.000	98.458
15	31.290	28.925	14.167	13.967	11.500	11.000	25.000	98.354
22	29.795	27.988	14.000	13.800	11.250	10.750	25.000	98.000
29	28.835	27.438	14.000	13.800	11.000	10.500	25.000	97.333

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis. All prices, except gold and silver, are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.400c per pound, the average differential for delivery charges.

(b) Our export quotations for copper reflects prices obtaining in the open market and is based on sales in the foreign market reduced to the f.o.b. refinery equivalent. Atlantic seaboard. On f.a.s. transactions we deduct 0.125c for lighterage, etc., to arrive at the f.o.b. refinery quotion.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingots; cathodes are sold at a discount of 0.125c to 0.15c per pound. Quotations for zinc are based on Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East, Middle West, and West effective Jan. 1, 1951, commanded a premium of 1.35c per pound over the current market for Prime Western; Special High Grade 1.75c effective Dec. 1, 1955.

(f) Prime Western delivered where freight from E. St. Louis exceeds one-half cent.

Quotations for lead are based on domestic common lead. Corroding lead commands a premium of 10 pounds.

(c) The daily silver quotation reported by Handy & Harman, in cents and fractions of a cent per troy ounce, is the price paid by Handy & Harman in settlement for silver contained in unrefined silver-bearing materials submitted to them for refining. It is determined on the basis of offers of bar silver .999 fine as made to Handy & Harman for nearby delivery at New York by regular suppliers in quantities sufficient to meet daily requirements, and it is usually one quarter cent below the price at which such offers are made.

The Treasury's purchase price of newly mined domestic silver is 90.5 per troy ounce 1000 fine effective July 1, 1946. London silver in pence per troy ounce, basis .999 fine.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold is at 99.75 per cent of the price quoted by the Treasury, which is equal to $34.9125.

Silver, Gold and Sterling

DAILY AND AVERAGE PRICES

June 1957	Silver (c) New York	Silver London	Sterling Exchange	Gold London	Gold (d) United States
1	(e)	(e)	(e)	(e)	$35.00
3	90.875	78.500d.	278.9687	250s. 6¾d.	35.00
4	90.875	78.500d.	279.0187	250s. 6½d.	35.00
5	90.875	78.500d.	278.9125	250s. 9d.	35.00
6	90.875	78.500d.	278.7937	251s. 2½d.	35.00
7	90.875	78.500d.	278.7312	251s. 1d.	35.00
8	(e)	(e)	(e)	(e)	35.00
10	90.625	Holiday	278.8125	Holiday	35.00
11	90.625	78.500d	278.8562	250s. 11d.	35.00
12	90.625	78.500d.	278.9187	250s. 10¼d.	35.00
13	90.125	78.500d.	278.9531	250s. 11½d.	35.00
14	90.250	78.125d.	279.0000	250s. 11d.	35.00
15	(e)	(e)	(e)	(e)	35.00
17	90.250	78.125d.	279.2187	250s. 9d.	35.00
18	90.250	78.125d.	279.3125	250s. 6¾d.	35.00
19	90.250	78.125d.	279.1875	250s. 6¾d.	35.00
20	90.250	78.125d.	279.1250	250s. 7¼d.	35.00
21	90.250	78.125d.	279.0750	250s. 8¼d.	35.00
22	(e)	(e)	(e)	(e)	35.00
24	90.250	78.125d.	279.0937	250s. 8d.	35.00
25	90.250	78.125d.	279.0312	250s. 9¼d.	35.00
26	90.250	78.125d.	279.1562	250s. 9¼d.	35.00
27	90.250	78.125d.	279.1875	250s. 9d.	35.00
28	90.250	78.125d.	279.1250	250s. 9¼d.	35.00
29	(e)	(e)	(e)	(e)	35.00
AVERAGES FOR MONTH					
June	90.456	78.283	279.024	—	$35.00
AVERAGES FOR WEEK					
June					
5	90.875	—	278.983	—	$35.00
12	90.725	—	278.822	—	35.00
19	90.225	—	279.134	—	35.00
26	90.250	—	279.096	—	35.00

Calendar Week Averages: New York Silver: June 1st, 91.000; 8th, 90. 875. 15th, 90.450; 22nd, 90.250; 29th, 90.250.

(e) No market (Saturday).

London Metal Exchange Quotations

June	COPPER Cash Bid	COPPER Cash Asked	COPPER 3 Mo. Bid	COPPER 3 Mo. Asked	LEAD Current Month Bid	LEAD Current Month Asked	LEAD 3 Mo. Bid	LEAD 3 Mo. Asked	ZINC Current Month Bid	ZINC Current Month Asked	ZINC 3 Mo. Bid	ZINC 3 Mo. Asked	TIN Cash Bid	TIN Cash Asked	TIN 3 Mo. Bid	TIN 3 Mo. Asked
3	235½	235¾	237	237¼	97	97¼	97¼	97½	79½	79¾	78¼	78½	763½	764	761½	762
4	235¼	235½	237	237¼	96¼	96¾	96¾	97	79	79¼	77¾	78	762½	763	760½	761
5	234	234¼	235¾	236¼	94¾	95	95	95½	76½	76¾	75½	75¾	762½	763	759½	760
6	233¼	233½	235¼	235½	93¼	93¼	93¾	94	76¼	76¾	75¾	76	763	763½	760	760½
7	233	233¼	234½	235	92½	92¾	93	93¼	75¾	76	76½	76¾	763½	764	760	761
10	Holiday															
11	232	232¼	234	234¼	91	91¼	91¼	91½	74½	74¾	74	74¼	761½	762	758	758½
12	232¼	232½	234¼	234½	91¼	91½	91¼	91½	73	73¼	73	73¼	761½	762	759	759½
13	232¼	232½	234¼	234½	92	92¼	92	92¼	74	74¼	74	74¼	764	765	761	761½
14	231	231¼	232½	232¾	92	92¼	92	92¼	73½	74	74	74¼	763	764	760	760½
17	227	227½	228¾	229	91¼	91½	91¼	91½	73¼	73½	73¼	73½	763	764	760	761
18	222¼	222¾	224	224¼	89½	89¾	90	90¼	72½	72¾	72½	72¾	763	764	760½	761
19	222	222½	224	224¼	89¾	90	90	90¼	72¾	73	72½	72¾	762½	763½	760	761
20	220¾	221	222½	222¾	90	90¼	90¼	90½	72½	72¾	72	72¼	760½	761	758½	759
21	220½	221	222	222½	90	90¼	90½	90¾	72	72¼	71½	72	761	762	758½	759
24	221	221½	222¾	223¼	89⅞	90	90⅜	90½	71	71¼	71	71½	761	762	758½	759
25	221¼	221½	223	223¼	89½	89¾	90	90¼	71½	71¾	71	71¼	761	761½	758½	759
26	221¼	221½	222¾	223	89	89½	89½	89¾	72¾	73	72	72¼	761	761½	758½	759
27	220¼	220½	221¼	221½	89¼	89½	89¼	90	73¼	73½	72½	72¾	761	761½	758½	759
28	217¾	218	219	219¼	91¾	91½	91½	91¾	75½	76	74	74½	762	762½	758½	759
Avgs	t227.132		t228.809		t91.688		t91.987		t74.303		t73.868		t762.316		t759.737	

Prices are for the official a.m. session in pounds sterling per ton of 2240 lb. Copper basis wire bars, lead 99.97%, zinc 98¾ and tin min. 99.75%.

Miscellaneous Metals, Ores, Minerals

Quotations cover wholesale lots, prompt shipments f.o.b. New York unless otherwise stated, tons of 2,000 lb. unless otherwise noted. St—short ton; lt—long ton.

MISCELLANEOUS METALS

June 30, 1957

Aluminum ingot, 99 plus % lb.			27.1¢
Antimony, spot, lb. less than carload, in cases			36.59¢
In bulk, carload lots, f.o.b. Laredo			33.00¢
Bismuth, ton lots, lb.			$2.25
Cadmium, commercial sticks, delivered, lb.			$1.70
Calcium, lb. ton lots, 98%, cast			$2.05
Chromium, 97% grade, lb. contract del.			$1.29
Cobalt, 97 to 99%, per lb. eff. Feb. 1, 1957			$2.00
Germanium, per gram, 10,000 gram lots	(c)38¢	@	(d)45½¢
Indium, troy oz.			$2.25
Lithium, lb. 98%	$11.00	@	$14.00
Nickel, cathodes, lb. (a)			74¢
Other sales, reg. sellers	88¼¢	@	$1.05
Sales by dealers, etc.			$1.05
Magnesium, 99.8% carloads, lb. producer's plants, Velasco, Texas, eff. Apr. 16			35¼¢
Palladium, troy oz.	$21.00	@	$22.50
Platinum (wholesale lots), troy oz.	$88	@	$95
Quicksilver, flask of 76 lb., 25 flasks or more	$255	@	$257
Selenium, 99 plus %, lb. (May 28, 1957)			$10.50
Silicon, minimum 97%, carloads, lb.			20¢
Semi-Conductor grade, lb.			$350
Tellurium, lb.			$1.65
Thallium, 100 lb. or more, lb.			$12.50
Titanium, 99.3 plus. grade A-1, max. 3% iron, lb.			(b)$2.25

(a) Eff. Dec. 6, 1956; incl. U. S. duty; (b) Effective June 3, 1957.
(c) Delivered; (d) f.o.b. plant

METALLIC ORES

Beryllium Ore, imported, 10% BeO, per short ton unit	$36.00	@	$37.00
Chrome Ore per long ton, f.o.b. cars Atl. ports, dry:			
44% Cr_2O_3 no ratio	$30	@	$30.50
48% Cr_2O_3 3 to 1 ratio	$52	@	$59.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:			
Old Range bessemer			$11.85(e)
Mesabi bessemer			$11.60(e)
Mesabi, non-bessemer			$11.45(e)
Lead (Galena), 80%, Joplin, Mo., ton			$170.52
Manganese Ore—Per long ton unit of Mn basis 48% manganese, nearby positions, subject to premiums and penalties, c.i.f. U. S. ports, import duty extra, export duty included, $1.45 @ $1.49; both duties excluded, $1.315 @ $1.355. Long-term contract nominal.			
Molybdenum Ore, 90%, per lb. of Mo f.o.b. mines	$1.18	@	$1.23
Columbium-Tantalum, per lb., combined oxides 10 to 1 ratio	$1.35	@	$1.40
Tungsten Ore, per unit of WO_3:			
Foreign 60%, c.i.f. U. S. ports, duty extra	$15.75	@	$17.50
U. S. mined concentrate, per stu, f.o.b. mill (GSA price) (Suspended)			$55
Vanadium Ore, per lb. of contained V_2O_5 f.o.b. mines			31¢
Zinc Ore, Prime, 60% concentrate, Joplin, Mo., per ton			$60.00

(a) Nominal.
(e) Eff. 1957 shipping season.

METALLIC COMPOUNDS

Arsenous Oxide (arsenic trioxide) lb., in bbl carload lots delivered			5½¢
Cobalt Oxide, 72½% to 73½%, per lb. eff. Dec. 1, '56	$1.52	@	$1.55
Copper Sulphate, 100 lb. eff. Oct. 25, '56			$13.90
Germanium Oxide, gram			27½¢
Molybdic trioxide, technical, per lb of Mo	$1.38	@	$1.41

ALLOYS

Ferrochrome 65 to 70%, per lb. of Cr, (4-9% C)			27¾¢
Ferromanganese, 74 to 76%, per lb., shipg. pt.			12¾¢
Ferromolybdenum, 58 to 64% Mo, lb. of Mo contained	$1.68	@	$1.74
Ferrosilicon, 50% per lb. of Si f.o.b. shipping point (3-19-57)			13¢
Ferrotungsten, 72 to 82%, lb. of W contained			$2.60
Ferrovanadium, per lb. of V delivered	$3.20	@	$3.40
Silicomanganese, max. 1½% carbon, lb., contracts			12.8¢
Spiegeleisen, per long ton, 19 @ 21% grade eff. Jan. 7			$102.50

NON-METALLIC MINERALS

Asbestos, f.o.b. Canada (Quebec) mines (U. S. funds) ton:			
Crude No. 1	$1,400	@	$1,725
Crude No. 2	$750	@	$1,100
Spinning fibers	$350	@	$650
Shingle fibers	$190	@	$210
Paper stock	$114	@	$137
Waste	$82	@	$84
Shorts	$28	@	$75
Asbestos, f.o.b., Vancouver, B. C. (U. S. funds):			
Spinning fibers	$470	@	$750
Shingle fibers, effective Jan. 1	$210	@	$310
Asbestos, Vermont, f.o.b. Hyde Park:			
Spinning fibers	$353	@	$383
Shingle stock	$172	@	$190
Paper stock	$114	@	$145
Waste, stucco or plaster			$82
Refuse or Shorts	$39	@	$72
Barytes f.o.b. cars:			
Georgia, crude, per ton			$18
Missouri, 94% $BaSO_4$, per short ton	$16	@	$18
Crude oil well grade, min. 4.3% sp. gravity, st (a)			$18
Imported, c.i.f. Gulf Ports, st	$16	@	$18
Bauxite, long ton, f.o.b. point of shipment:			
Domestic, crude, 50 to 52% (not dried)	(a)$ 5.00	@	$5.50
Domestic, chemical, 55 to 58%	(a)$ 8.50	@	$9.05
Domestic, abrasive, 80 to 84%	(a)$18.00	@	$18.50
Imported metallurgical, per lt, f.o.b. Br. Guiana, dep. on grade			$7.14
Feldspar, bulk ton:			
Potash or soda feldspar, 200 mesh, ceramic grade	$18.50	@	$22.50
Glass feldspar, white, 20 mesh	$11.75	@	$12.50
Fluorspar, f.o.b. mines, bulk, 72½% effective, ton	$37	@	$41
60% effective CaF_2	$33	@	$36.50
Acid 97% concentrate, bulk, ton (eff. 12-1-56)			$50.00
Some sales at			$55
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00	@	$14.00
Magnesite, per ton dead-burned, bulk, f.o.b. Washington			$40.00
Mica—Domestic, f.o.b. mines. Punch 7¢ to 12¢ per lb. according to size and quality. Sheet clear, 1½ x 2-inch, 70¢ to $1.10; 2 x 2-inch, $1.10 to $1.60; 2 x 3-inch, $1.60 @ $2.10; 3 x 3-inch, $1.80 @ $2.30; 3 x 4-inch, $2.00 @ $2.60; 3 x 5-inch, $2.60 @ $3.00; 4 x 6-inch, $2.75 @ $4.00; 6 x 8-inch, $4.00 @ $8.00. Wet ground, very fine, $140 @ $155 per ton. Bulk sales, dry ground: $32.50 @ $70.00 per ton. Scrap, $25 and up.			
Ocher, Georgia, ton, in sacks	$26.50	@	$32.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports			Not quoted
Sulphur, per lt, f.o.b. U. S. mines: bright			$26.50
dark			$25.50
Mexican, per lt, f.o.b. mines, dark, 280 pesos			$22.40
Talc, f.o.b. works, ton:			
New York, purified	$18.00	@	$20.00
Vermont, extra white			$12.50
Tripoli, Missouri, ton:			
40-mesh, cream colored			$50.00

(a)Some restricted sales at $11.50. (b) Corrected.

IRON AND STEEL

Pig Iron, gross ton, basic, Valley Furnaces			$64.50
Steel, f.o.b. Pittsburgh, billets, net ton			(a)$74.00
Structural shapes, Pa., Ala., etc., 100 lb.	(b)$4.85	@	$5.00

(a) $77.50 eff. July 1; (b) $5.10 @ $5.275 eff. July 1

THIS MONTH IN MINING

Pickands, Mather Signs Labrador Iron Ore Pact

THE COMPLEX HISTORY of the iron ores of southwest Labrador, U.S. iron mining companies and Canadian Javelin gained another chapter last month with announcement of formation of Wabush Iron Co. Ltd., composed of Pickands, Mather & Co., Steel Co. of Canada and Canadian Javelin.

PM is managing agent of Wabush Iron, with Javelin holding a 10% interest which may be purchased by the owners at an agreed price. Ownership exclusive of Javelin may be increased by entry of other iron ore-consuming firms in the U.S., but PM notes contracts are in the preliminary stage. Group, exclusive of Javelin, would put up required funds and share proportionately in output from the property.

Wabush Lake deposit is still being investigated by PM, which says that partial drilling by Javelin and samples by PM indicate a relatively soft, coarse-grained ore in the area which contains magnetite, hematite and specularite. Concentrates, according to PM, ran between 64- and 66% iron and could be concentrated to approximately 70% "if more complicated processes are used." The orebody is covered by relatively shallow overburden with occasional outcrops. Newfoundland government estimates the ore at more than 1-billion tons.

"At the present time," Pickands, Mather notes, "no definite plans for an actual concentrating plant exist. This summer, PM plans to proceed with exploration, testing and planning, using drill rigs and other equipment to drill the area thoroughly, define the limits of the orebody as much as possible, and determine its analysis and concentrating characteristics.

"It must be understood that until the orebody is thoroughly explored, the ore analyzed and tested, and drawings for a proposed plant and auxiliary facilities made, no authentic statement can be made as to the size or nature of any project of the PM-Stelco group or whether the property will be developed."

PM points out that a plant with annual production of less than 2.5-million tons would not be economical. Current plans consider an open pit.

Canadian Javelin has been working for some time on a railroad connection from Wabush Lake to Mile 224 of the Quebec, North Shore and Labrador railway which connects Seven Islands and Knob Lake. Grading for about the first half of the 37-mile line is complete.

The principal provisions of the Wabush Iron-Canadian Javelin agreement are listed as follows:

1. Wabush Iron will pay to Canadian Javelin approximately $7.2-million. The initial payment is $2.5-million upon signing of the various agreements involved, with the balance payable later if it is determined to proceed with the development of the property.

2. A portion of the initial payment of $2.5-million will be used by Canadian Javelin to retire the outstanding bonds of the Wabush Lake Railway Company Limited. The original bond issue aggregated $16.5-million, of which approximately $2-million have been issued.

3. The Government of Newfoundland will receive 22¢ a ton on all iron ore shipped by Wabush Iron in lieu of other taxes on the mining of iron ore, the severance thereof, ore reserves and real property.

4. The lease granted to Wabush Iron will have a term of 98 years and can be terminated at any time on twelve months' prior written notice.

5. Wabush Iron will pay to Javelin a royalty of 7% of the Seven Islands price of iron ore shipped by Wabush Iron but not less than 75¢ per gross ton.

6. Wabush Iron will pay minimum royalties to Javelin commencing with the year 1961 in the amount of $2-million per year and increasing to $5-million per year in 1969 and thereafter. These amounts are subject to reduction when the United States steel operations are less than 85% of capacity.

7. The payments to Canadian Javelin by Wabush Iron will purchase equipment and lands owned by Javelin, reimburse Javelin for exploration and development work, and will purchase 90% of the stock of Wabush Lake Railway Company Limited.

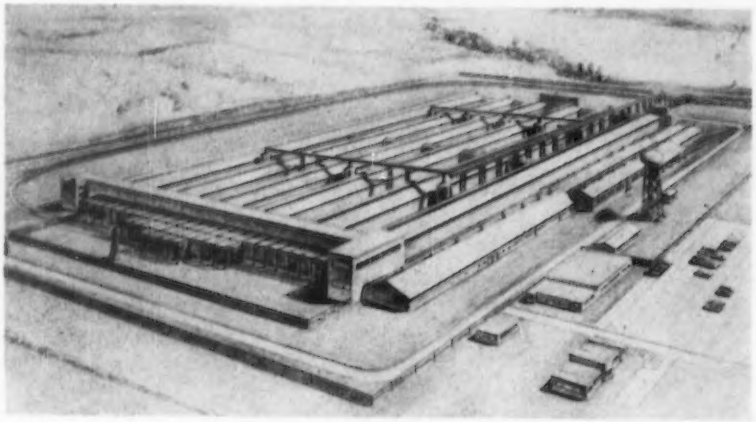
8. Javelin will own 10% of the stock of Wabush Iron and Wabush Railway, which can be purchased by Wabush Iron at an agreed price.

9. Pickands Mather & Co. has agreed under certain conditions to act as manager for possible iron ore mines which may be developed by Javelin in its concession area.

Inco Joins Titanium Base Alloy Project

INTERNATIONAL NICKEL CO. of Canada, Ltd., has made a $21,000 grant to aid a special research project involving study of titanium-base alloys at the Department of Mining and Metallurgy, University of Alberta, Edmonton.

This three-year study will be under direction of J. Gordon Parr, associate professor of metallurgy. The study will include investigations into mechanical



TARGET DATE for Reynolds Metals Co. Massena reduction plant is mid-1959.

$88-Million Plant Dedicated by Reynolds

GROUND-BREAKING for a new aluminum reduction plant of Reynolds Metals Co. took place in mid-June at Massena, N.Y., with leading dignitaries of New York State, the St. Lawrence Power Authority, Reynolds and General Motors Corp. taking part.

The $88-million plant will have an estimated annual capacity of 200-million lb primary aluminum, and when it begins production in 1959, will bring Reynold's total output to about 1.4-billion lb or 700,000 tons per year. Massena plant will have three potlines, utilizing 200,000 kw of "firm" power and 39,000 kw of "interruptible" power from the St. Lawrence Power Authority. Contract runs for 33 years. Plant is on a 1700-acre tract outside of Massena.

Alumina for the plant at Massena will come from Reynolds installations at Corpus Christi, Tex., or from Arkansas. Studies are being conducted on the feasibility of shipping via the St. Lawrence Seaway.

General Motors will construct a die-casting foundry adjacent to the Reynolds plant and be a "substantial" customer of the facility. Completion target is mid-summer of 1959.

properties of alloys and the possibilities of producing high-purity alloys in forms amenable to heat treatment.

This project is a continuation of research started by the professor at the University of British Columbia prior to his joining the University of Alberta.

Professor Parr serves as a consultant to Sherritt Gordon Mines Ltd., Fort Saskatchewan, Edmonton Steel Fabricators and Premier Steel Mills.

Mining Calendar

New Mexico Geological Society eighth annual field conference. Durango-Silverton-Ouray area of Colorado. Mrs. Marion Burks, Box 652, Socorro, N.M. Sept. 5-7

American Mining Congress, 1957 Metal Mining and Industrial Metals Convention, Salt Lake City. Sept. 9-12

International Mineral Dressing Congress, Stockholm Sweden. Sept. 18-21

Exploration Drilling Symposium, University of Minnesota, Minneapolis, Minn. Oct. 3-5

Society of Mining Engineers annual meeting and Southeastern States Mining Conference, AIME. Hotel Hillsboro and Hotel Tampa Terrace, Tampa, Fla. Oct. 15-18

Rocky Mountain Minerals Conference, AIME, Denver, Colo., Oct. 30-Nov. 1

American Society for Metals, second world metallurgical congress. Chicago, Ill. Nov. 2-8

Institute of Metals (London) inaugural meeting of powder metallurgy group. Church House, London. Dec. 4

Uranium Reduction Co. Asks For Capacity Hike

URANIUM REDUCTION CO. has formally proposed to Grand Junction Operations Office of Atomic Energy Commission that its Moab concentrator capacity be hiked from 1,500 to 1,700 tpd through conversion of a circuit to alkaline leach process.

The two circuits currently are resin-in-pulp.

William Hutchinson, administrative assistant to operations office manager Allen E. Jones, said that URC was currently submitting cost data on its proposal.

He made this statement in answer to a question of whether URC was being asked to accept a lower price on uranium oxides produced in return for the new contract from the AEC.

Approval of the new contract would permit Uranium Reduction Co to mill the ore contained in the Cord mine owned by Jen, Inc., Salt Lake City. Other millers, including Vitro Uranium Co., a division of Vitro Corporation of America, are seeking contracts with Jen on this ore.

Vitro's contracts with Atlas Corp.'s Hidden Splendor Mining Co. for ore expire at end of this year.

As We Went to Press . . .

U. S. Steel's Columbia-Geneva Steel Div. has decided to exercise its option on the low-grade iron ore properties near Atlantic City, Wyo., which it has been testing since the first of the year.

But the company may not decide whether to go ahead with the project until 1958, sources say. Plans would involve construction of a $16-million magnetic-process mill and an 82-mile railroad spur.

Columbia-Geneva is leasing the 1,200-acre property for 75 years from Ruby Co. of Boise, Idaho. It may be terminated at lessor's option. The Atlantic City deposit, located 26 miles south of Lander, would supply ore to Columbia-Geneva's steel mill at Provo, Utah.

A new titanium process for ilmenite ores may be forthcoming from the Armour Research Foundation of Illinois Institute of Technology, according to the *New York Times*. New method crushes ilmenite, rutile or titanium slag and treats it with concentrated sulphuric acid.

Two controlled crystallization steps reduce iron content and solution is treated with hydrogen chloride and solid potassium chloride. Potassium chlorotitanate precipitates out with further cooling and the complex salt of titanium is decomposed, yielding pure titanium tetrachloride after condensation of the liquid.

Clark E. Thorp, manager of chemistry and chemical engineering, noted that development of the "cold chlorination" process will take further study.

Switch to open pit from underground by U. S. Borax & Chemical Corp. at its Boron, Calif., property is now complete. Some 9-million tons of overburden had to be removed by Isbell Construction Co. before U. S. Borax could begin mining. New $18-million refinery at the site, already in partial operation, will be in full production by the end of September.

"Notable percentages of uranium" have been discovered in northern Italy, according to the regional administration of Trentino-Alto Aldige, which has granted 17 permits for prospecting in the area.

The island of Sardinia is also the site of uranium prospecting, in the central mountainous region, by the state-owned Somiren.

GSA will stockpile $1-million worth of antimony metal from Sunshine Mining Co., according to the company. John Edgar, manager of the company's mining division, says the contract calls for delivery of 1,500 tons of antimony over an 18-month period, starting this month. Sunshine is installing equipment to refine the impure cathode antimony metal which it has been producing at its electrolytic plant.

Mining is due in six months at Exploraciones Rosario, S.A., subsidiary of New York Honduras Rosario Mining Co., which will operate a manganese property in the Province of Colón, Panama.

Globe, Ariz. ore-buying station closed June 30. AEC noted that "no significant new discoveries have been made in the last six months. . . . Total estimated reserves in the district are less than 100,000 tons, including the 23,000 tons delivered to the buying station during the past 23 months. These reserves are only a fraction of the tonnage required for an economic (Globe area) mill operation."

Behind the By-Lines...

G. P. Lutjen

One of the hot spots in iron ore exploration these days is truly Chile. Companies in the field are paying a lot of attention to the rugged West Coast of South America. Chile's potencial is examined in close detail on p 90 by an authority on the iron resources of that country, our old friend and frequent contributor, Fernando Benitez. Sr. Benitez has been gathering material on the subject for more than 30 years. After sifting it carefully he has put together everything worth knowing about iron in Chile. Here's an excellent chance to get up to date on an important development in a hurry.

An article on a Bagdad pilot plant may sound to the uninitiated like a story on a training school for Arabian carpet jockeys, but we know better. What it is, is the description of a new process developed by the Southwest's Bagdad Copper Corp., for treating both sulphide and oxide ores. Key to the process is the use of FluoSolids to control oxidation of the iron. Whys and hows are available on p 86.

Two and a half years have passed since we arranged the musical program for the *E&MJ* Chowder, Marching and Margaret Sullavan Society's Eighth Underground Saturnalia, but we still remember the haunting strains of one of the evening's most popular selections, "I Was Seeing Moly Chrome." (It ran neck and neck with "I've Got U Under my Tin.") In this present issue, seeing Moly Chrome becomes more than a song; it becomes 5 pages of useful reading for mill men everywhere. Besides showing how to select mill liners, it contains some interesting ideas on liner wear and what you can do about it.

One point on liner wear has been taxing our fast-waning knowledge of descriptive geometry. It seems that when a ball mill rotates in a clockwise direction, the wear pattern of the liner assumes a counter-clock-wise spiral. This kind of confusion will probably bring back the square ball mill.

Our What-Does-the-Public-Know-About-Mining Research Department (TV Division) has come through with some illuminating if unofficial figures based on a survey of some 40 daytime and/or nighttime viewers in and about New York. In the thousands of television plays produced in the past three years, mining has figured in no more than three. We are excluding for the moment, Horse Operas and the casual mentions like one we heard on a program the other day—"Fairweather has gone to Colorado to discover a silver mine."

In all three cases the mine in question was a coal mine which in all cases, had just had an explosion underground, trapping miners in the nether reaches. Plot A dealt with the miners' wives waiting for a word at the headframe. It apparently aimed to prove in 30 minutes that all gals from the boss' lady to Judy O'Grady are sisters under the skin. Plot B dealt with the trapped miners, two of whom were mutually antagonistic over some doll. Moral turned out to be that women will never replace a good rescue squad. Plot C used the mine explosion to turn a nasty old mine owner into a sweet, lovable guy just aching to give the miners an extra holiday on St. Swithin's Day and a flask of Chanel No. 5 at the intake of every blower.

Now we ask you—what kind of impression does the general public get of mining from slop like that? On the basis of the evidence, it would appear that mining's chief value is the creation of disasters for solving the emotional problems of assorted neurotics.

The visit to Bingham Canyon on the Wide Wide World program a while back is an excellent antidote to this sort of thing and there should be more of it. Maybe we ought to invade the drama field too. Why doesn't some mining man with a typewriter and a penchant for writing turn out a television script that gives our industry a better shake?

Next month; "Mining in the Horse Opera" or "Roy Rogers Falls Down an Open Stope."

Must be a full moon or something. How else can you explain the following items:

A news release from Goodyear. Akron, Ohio—A lawsuit charging patent infringement against Morin Plenty is being talked about here in the Shoe Products Div. of Goodyear Tire & Rubber Co. The suit won't get past the talking stage because Morin Plenty couldn't be reached for legal service, since his home is in the ink bottle of Chester Gould, creator of the Dick Tracy comic strip.

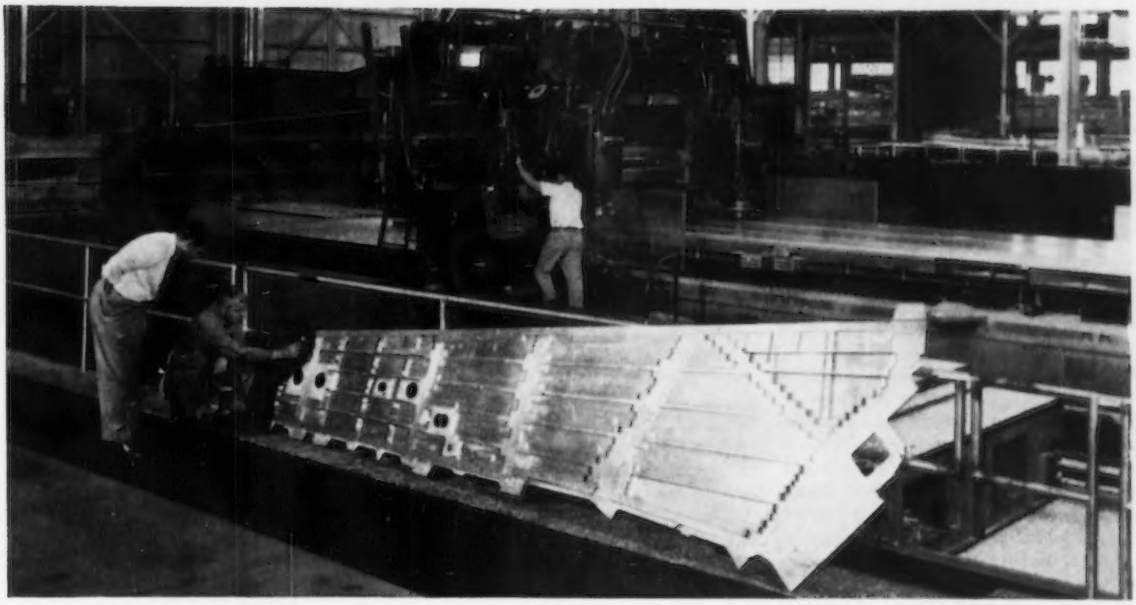
Currently Morin Plenty, father of B. O. Plenty, is seeking to market in the world of cartoon characters his "heels-a-plenty" heel. Morin's invention has a rubber heel, round in shape and adjustable so that as one point wears, it can be rotated.

The trouble that Morin Plenty would run into should he get out of his inkwell and into the real marts of trade, would be that of running smack into a patent infringement situation with Goodyear, whose English subsidiary developed an almost identical idea back in 1941 and currently is selling 5,000 to 6,000 pairs of rotating heels monthly in England. A comparison of the Goodyear patent drawing with Morin Plenty's sketches, as published in the cartoon strip, reveals a remarkable similarity in the two designs.

A note on inflation from McGraw-Hill's Department of economics. The Michigan Legislation has raised from $50 to $100 the amount of money you must steal to commit a felony rather than a mere misdemeanor.

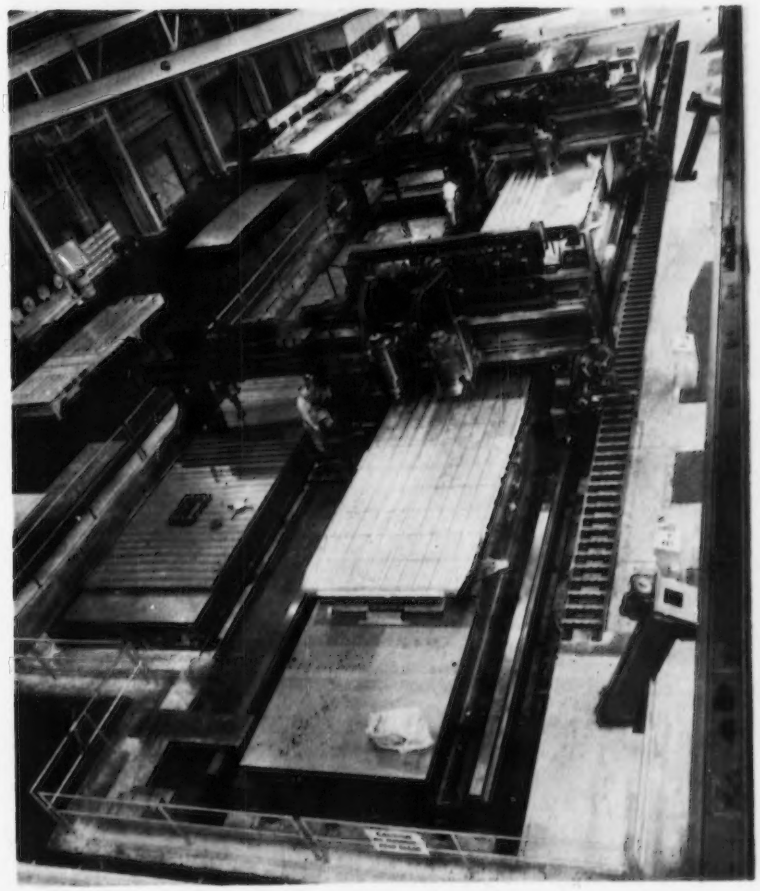
A note from an anonymous contributor.

One day as I sat musing, sad and lonely and without a friend, a voice came to me from out of the gloom saying, "Cheer up, things could be worse." So I cheered up, and sure enough things got worse.



SINGLE, TAPERED-PLATE wing sections are cut in one piece. Reynolds' huge skin mills cut away up to 85% of the metal.

Reynolds Opens King-Size Plate Mill



SKIN MILLING the wings eliminates the need for riveting a skin to a wing frame.

TO CATCH UP WITH modern aircraft design, Reynolds Metals Co. dedicated a new fabricating operation, the Roy A. Bath facility, for the production of wings and other large parts of our military and commercial aircraft at ceremonies conducted at Reynolds' McCook, Ill. works on May 28, 1957.

To meet the increasing demand for larger, longer and more intricate aluminum alloy sheet and plate, Reynolds contracted with the U. S. Navy in 1952 to build and operate this new facility which began producton last December. Total cost of the equipment installed is $20-million, with the U.S. Navy owning 75% of the units. Reynolds has the right to use, for a fee, the equipment to satisfy a growing commercial aircraft demand for the same products.

At a press conference attended by reporters and editors from all over the U. S., prior to the dedication, R. S. Reynolds, Jr., president, Reynolds Metals Co., said that Reynolds was not pointing toward the jet aircraft industry with this new installation, but instead toward military transport and commercial aircraft, and military airborne vehicles, where aluminum's light weight still is in demand.

Since the start of operations last

fall, the Bath facility has supplied parts for every major aircraft manufacturer. It has also produced plate for ships and containers for the chemical processing industry.

New facility includes a 145-in. tapering rolling mill capable of rolling 4-ton ingots to 100-ft length and 145-in. width, two giant gantry-type skin milling machines that can handle 100-ft plates, a plate stretcher with a pulling force of 16-million lb, and large suction-lift cranes that can handle the giant plates and sheets produced in this operation.

Aluminum pig comes to McCook from Reynolds' primary smelters to be remelted and alloyed, then sampled and cast into ingots weighing up to 4 tons. The sample is sent to the spectrographic laboratory in the plant, where from five to nine elements are determined within five minutes time.

After the ingot has cooled, it goes to a scalping and scaling machine that prepares a smooth, even surface on top and bottom side. Then the ingot is homogenized in soaking pits to prepare it for the 145-in. rolling step. The tapering rolls first roll the ingot for width, then turn it around and roll for taper and length.

From the rolling mill stand, the plate with its desired length, width and end-to-end taper is sawed and trimmed to remove excess metal, then stretched to relieve internal stress and strain. Now the plate is ready for sculpturing and contouring to the desired size and shape on the skin mills. Reynolds is developing a vacuum pick-up method to assist in reclaiming the chips that come off the skin miller.

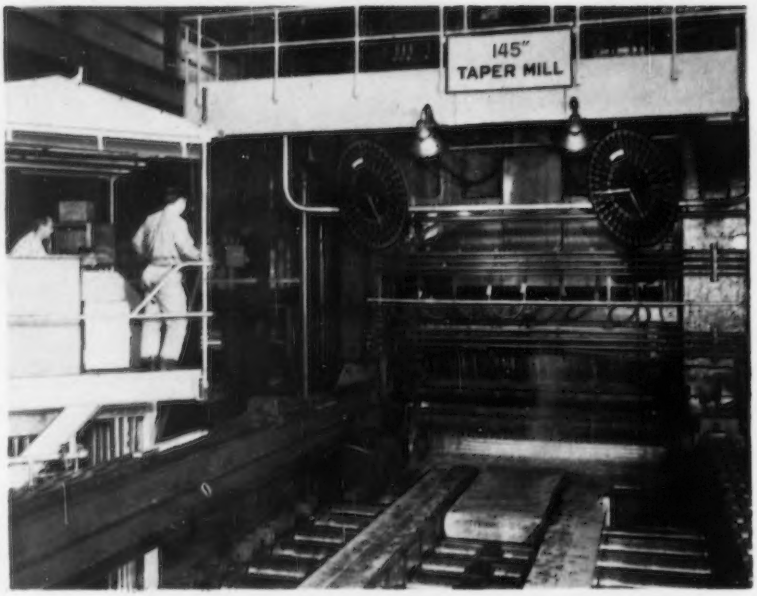
Reynolds has installed two remelting furnaces to reclaim and remelt the chips and scrap. Each alloy is kept separate and after remelting, is tagged and used as an alloy constituent in subsequent batches.

Ultrasonic Testing

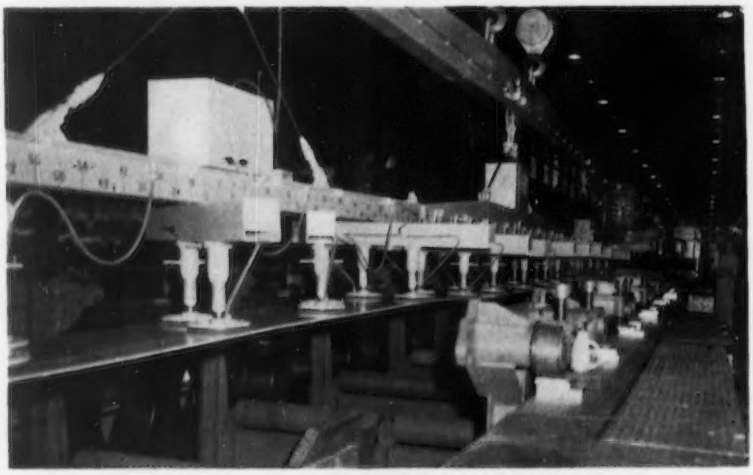
The finished plate or sheet may be subjected to ultrasonic testing to check for hidden imperfections.

In addition to the new equipment, Reynolds has installed aging furnaces, horizontal-type heat treating furnaces for the large plate, soaking pits, and the vacuum pick-up cranes.

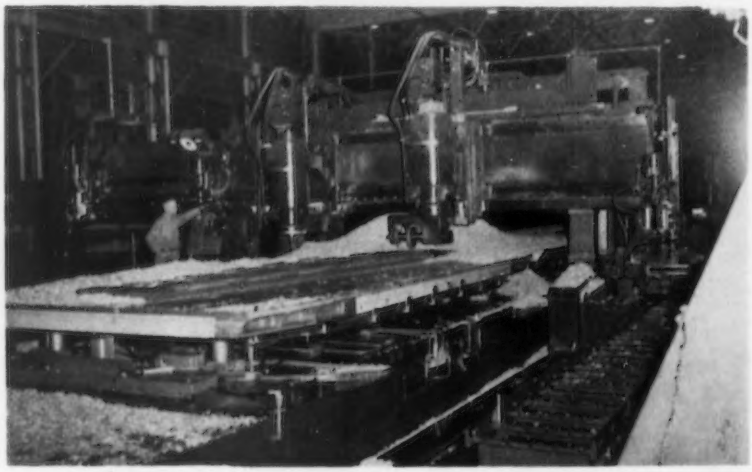
The original McCook plant was built during World War II at a cost of $43-million and has a capacity of 35-million lb of sheet and plate per month. This is about half of Reynolds sheet and plate capacity. The Bath facility occupies five acres of the total 60-acre plant, all under one roof. The plant also turns out coiled, flat, corrugated, embossed and painted sheet, and flat plate in a wide variety of alloys, tempers and sizes.



PLATES are rolled to desired taper and dimension before the skin milling step.



LIFTING and positioning the rolled sheet is done with these suction-lift cranes.



SKIN MILLING machine in action. Sheet is contoured and sculptured to Navy needs.

How to Determine Material Balance By Ratio-Scale Moments Method

E. B. FITCH

E. J. ROBERTS

MANY CHEMICAL and metallurgical engineering problems involve material or constituent balance calculations. For example, a feed stream may be split into two or more effluent streams of different compositions. It is desired to make a balance of the split based on the known compositions of the streams. In another case the system may comprise two phases, liquid and solids. It is desired to calculate the per cent of each phase present from known properties (such as specific gravity) of the phases and the system. It takes time to set up equations in terms of known analysis of flows and to solve them for the proportion of material in each split.

Phase chemists use a mechanical analog that simplifies setting up the necessary relationships. This device, known as the "center of gravity principle" or "lever principle" makes use of the mechanical principle that the moment exerted by a system is the same whether the system is considered as a whole or is split into parts.

The method of moments uses the ratio of two magnitudes provided that the sum of the magnitudes associated with each split is equal to the magnitude associated with the whole system. That is:

$$A_1 + A_2 = A_s$$

and

$$B_1 + B_2 = B_s$$

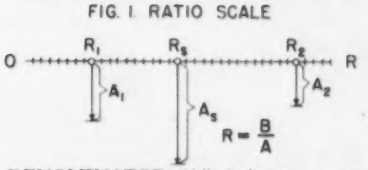
When

A_1 = magnitude of A in first phase or split
A_2 = magnitude of A in second phase or split
A_s = magnitude of A in system
B_1 = magnitude of B in first phase or split
B_2 = magnitude of B in second phase or split
B_s = magnitude of B in system

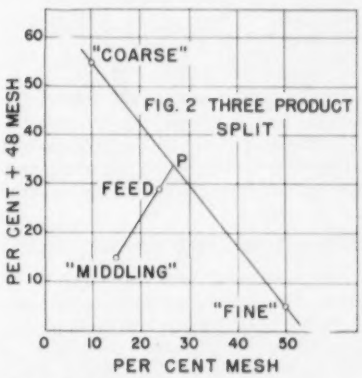
As an example, A might be mass or weight. Sum of the weights of the splits equals total weight of system. If B is the mass or weight of one of the chemicals forming a component of the system, sum of the weights of B in the splits equals total B in system. Both of these satisfy the condition. Then the ratio B/A in any stream is the analysis by weight for component B in the stream.

Mr. Fitch is director of the Westport Laboratories and Mr. Roberts is director of research and development Dorr-Oliver Inc., Stamford, Conn.

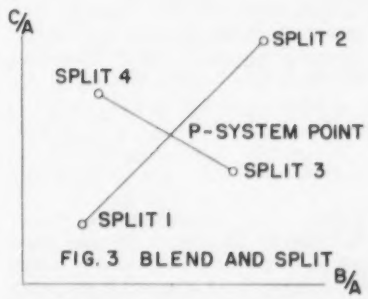
FIG. 1. RATIO SCALE



DENOMINATOR "A" designates quantity for which materials balance should be made. Moments are about any point.



SEE EXAMPLE 4 for explanation of this graph used to solve a problem involving coarse, fine and middling products.



GRAPH shows how to solve problem involving interaction of two flows followed by separation.

Draw a scale for the ratio B/A, as in Fig. 1, where A, the denominator, is the quantity for which material balance is made. Take moments about any chosen point on scale. Moment is magnitude A times scale distance. Set sum of moments of splits equal to moment of system. Thus taking moments about R_1, or B_1/A_1,

$$A_2 (R_2 - R_1) = A_s (R_s - R_1)$$

substituting B/A values for R values and transposing

$$\frac{A_2}{A_s} = \frac{(B_s/A_s - B_1/A_1)}{(B_2/A_2 - B_1/A_1)}$$

Fraction of the system going to split two is expressed as a function of weight analysis for B in the system and in splits.

Moments could also be taken about scale point B_s/A_s and an expression for material balance ratio A_1/A_2 obtained. Moments taken about scale point B_2/A_2 would yield material balance ratio A_1/A_s. Of the three material balance quantities A_1, A_2 and A_s, the one corresponding to the point about which moments are taken will be the one missing from the material balance ratio finally obtained.

Example 1—How to Determine Per Cent Solids in a Slurry

A slurry is composed of solids, specific gravity 2.6 and liquid of specific gravity 1.0. Weight of 1,000 cc of slurry is 1,296 grams. What is weight per cent solids in slurry?

Volume of solids + volume of liquid = volume of slurry

Weight of solids + weight of liquid = weight of slurry

Density, d = wt/vol. To obtain weight balance directly, weight must be in denominator of ratio used. Therefore ratio scale R will be in vol/wt or 1/d and three necessary values for R become:

$$R_{solids} = \frac{1}{2.6} = 0.385$$

$$R_{liquid} = \frac{1}{1} = 1.000$$

$$R_{slurry} = \frac{1000}{1296} = 0.772$$

It is desired to show weight of solids as a function of weight of slurry, take moments about R_{liquid}, the scale point corresponding to liquid.

$$\frac{\text{Wt solids}}{\text{Wt slurry}} = \frac{0.772 - 1}{0.385 - 1} = \frac{-0.228}{-0.615} = +0.371$$

Thus the slurry is 37.1% solids.

Example 1 — Alternate Solution for Same Problem

A volume balance could be made with densities directly. Density equals weight divided by volume (volume is where it is needed, in denominator). Thus, using d for R and taking moments about "liquid" point:

Vol solids $(d_{solids} - d_{liquid})$ = vol slurry $(d_{slurry} - d_{liquid})$

Therefore:

$$\frac{\text{Vol solids}}{\text{Vol slurry}} = \frac{(1.296 - 1)}{(2.6 - 1)} = \frac{0.296}{1.600} = 0.185 \text{ or } 18.5\%$$

$$\frac{\text{Wt solids}}{\text{Wt slurry}} = \frac{\text{Vol solids} \times \text{density of solids}}{\text{Vol slurry} \times \text{density slurry}} = 0.185 \times \frac{2.6}{1.296} = 0.371 \text{ or } 37.1\%$$

Example 2—How to Determine Loss of Copper to Tails

A flotation plant treats ore containing 0.93% copper to produce concentrate running 29.8% and tails running 0.11% copper. What is the loss of copper to the tails?

Wt concentrate + Wt tails = Wt feed

Cu in concentrate + Cu in tails = Cu in feed

Since split of copper is required, copper must appear in denominator of ratio. Per cent copper is copper divided by total weight, therefore scale ratio will be 1/per cent copper. It is desired to show copper in tails as a function of copper in feed. The moments about scale point for concentrate.

$$(\text{Cu in tails})(R_{\text{tails}} - R_{\text{conc}}) = (\text{Cu in feed})(R_{\text{feed}} - R_{\text{conc}})$$

or

$$\frac{\text{Cu in tails}}{\text{Cu in feed}} = \frac{\frac{1}{0.93} - \frac{1}{29.8}}{\frac{1}{0.11} - \frac{1}{29.8}} = \frac{1.075 - 0.034}{9.09 - 0.034} = \frac{1.041}{9.06} = 0.115$$

Copper loss is 11.5%.

Example 3—How to Solve a Rake Classifier Problem

A classifier produces fractions with size analysis as follows:

Per Cent Cumulative Plus Mesh

Mesh	Feed	Overflow fines	Rake sands	Split to rake*
10	10.6		13.4	0.791
14	15.0		19.2	0.781
20	20.6		25.9	0.795
28	29.4		36.8	0.799
35	42.9	0.23	54.0	0.794
48	58.0	3.89	72.5	0.789
65	69.1	15.40	83.3	0.791
100	76.4	27.20	89.4	0.791
150	81.2	36.70	92.5	0.797
200	84.1	45.00	94.0	0.797

*As calculated by ratio scale moment method.

What fraction of the feed goes to the rake product?

Total wt fines + total wt coarse = total wt feed

Wt any size in fines + wt same size in coarse = wt in feed

Total weight split is desired so total weight must be in denominator. Screen analysis is expressed as weight of size band divided by total weight, therefore screen analysis figures can be used directly for R in moment equations. Also any screen partial or size band can be used to calculate the total weight split. All should give the same answer. If they do not, size analysis figures are inconsistent because, either samples were not representative, or screen analysis was faulty.

Take moments about fines scale point:

(Wt of rake) (% partial in rake − % partial in fines) = (wt of feed) (% partial in feed − % partial in fines)

$$\frac{\text{Wt of rake}}{\text{Wt of feed}} = \frac{(\%\text{ partial in feed} - \%\text{ partial in fines})}{(\%\text{ partial in rake} - \%\text{ partial in fines})}$$

As calculated for 48 mesh band:

$$\frac{\text{Wt of rake}}{\text{Wt of feed}} = \frac{58.0 - 3.80}{72.5 - 3.80} = \frac{54.2}{68.7} = 0.789 \text{ split to rake}$$

Split to rake as calculated for each screen size is shown in last column of screen analysis table. Split as calculated is consistent so sampling and screen analyses were representative.

More Than Two Product Splits

A system may be divided into more than two products. Such splits can be calculated if there are as many independent "magnitude" equations as there are products. Thus for a three product split:

$$A_1 + A_2 + A_3 = A_s$$
$$B_1 + B_2 + B_3 = B_s$$
$$C_1 + C_2 + C_3 = C_s.$$

Two ratios can be obtained, B/A and C/A. Each of these satisfies the moment equation. That is, taking moments about split 1:

$$A_2(B_2/A_2 - B_1/A_1) + A_3(B_3/A_3 - B_1/A_1) = A_s(B_s/A_s - B_1/A_1),$$
$$A_2(C_2/A_2 - C_1/A_1) + A_3(C_3/A_3 - C_1/A_1) = A_s(C_s/A_s - C_1/A_1)$$

Any of the magnitudes A_2, A_3, or A_8 may be eliminated between these equations and the resultant solved for one residual magnitude in terms of the other. Such problems are often more easily solved graphically as shown in the following example.

Example 4—How to Determine a Middling Split

A sand plant makes a coarse, fine and middling product. Screen analyses are as follows:

Per Cent Cumulative

Mesh	Feed	Coarse	Fine	Middlings
+48	29.	55	5	15
−100	24	10	50	15

What is the split to middling product?

Since total weight split is desired, total weight must appear in denominator of ratio fractions, so weight per cent can be used directly. Plot Fig. 2 with per cent plus 48 mesh on one axis against per cent minus 100 mesh on the other. Take moments around an axis joining the "course" and "fine" points on the plot. Scale distances normal to this axis would be used for calculating moments, but distances in any fixed direction will be proportional to normal distances and the proportionality constant will cancel out in a ratio of distances as used here. It is convenient to measure scale distance along a line through the points for "middlings" and "feed" so this line is drawn intersecting the moment axis at P. Scale distances are measured with a ruler as follows:

Feed to P = 1.45 units

Middlings to P = 5.75 units

Taking moments:

(Wt of middlings) × 5.75 = (wt of feed) × 1.45

$$\frac{\text{Wt of middlings}}{\text{Wt of feed}} = \frac{1.45}{5.75} = 0.252 \text{ or } 25.2\%$$

It is of interest that point P represents the weight composite of "coarse" and "fine" and that these are present in the ratio:

$$\frac{\text{Wt of "coarse"}}{\text{Wt of "fine"}} = \frac{\text{distance from "fine" point to P}}{\text{distance from "coarse" point to P}}$$

Blend and Split Operations

Many processes involve the mixing and interaction of two flows, followed by separation into two products. Typical of such processes are stagewise transfer operations like solvent extraction and leaching. These can be solved if three "magnitude" equations can be written.

$$A_1 + A_2 = A_3 + A_4$$
$$B_1 + B_2 = B_3 + B_4$$
$$C_1 + C_2 = C_3 + C_4.$$

Points are plotted on a graph as in Fig. 3 with the ratio B/A as one scale and C/A as the other.

System point is not known. However, the system is the sum of splits one and two, also of splits three and four. The system point has to be on a straight line joining points 1 and 2 and also on a straight line joining points 3 and 4. Therefore it is located at the intersection of these lines.

Once the scale ratio for the system point has been located, balance can be made from system to products as though it was a simple two-product split. Similarly, balance can be made from the two input streams to the system as though it were a simple two-product split, calculations for a product blend being the same as those for a product split.

Try Bubble Pick-Up For Rapid Flotation Testing

SHIOU-CHUAN SUN
R. C. TROXELL

USING A BUBBLE PICK-UP METHOD, as described below, laboratory flotation testing can be cut to a minimum, offering a quick, reliable and inexpensive method for determining optimum flotation conditions, for testing new reagents and reagent combinations and the most effective pH range.

Bubble pick-up uses a glass tube capable of producing a single bubble, which is touched against a sample of mineral under investigation, and which picks up an amount of mineral depending on the flotation conditions established for the test. Only the following are needed: pick-up tube, beaker, stirring rod or machine, reagents and a mineral microscope.

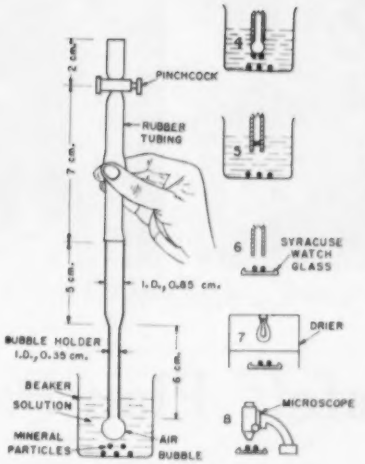
Using this procedure, a quick qualitative examination of a new reagent condition may be made. One test condition can be compared with another simply by counting the average number of particles collected under each condition.

Compared with the contact angle method, the quantitative bubble pick-up method is inferior in giving reproducable results. This can be partly remedied by repeating the test three or four times and using the average result.

Another weakness of the bubble pick-up method is that, on rare occasions, the mineral particles are overflocculated by the presence of a flotation reagent, and the resultant aggregates are too large to be picked up by the bubble. In this case, the large aggregates have to be broken into smaller flocs by means of a glass rod prior to the bubble pick-up test.

On the other hand, the bubble pick-up method not only is superior in sensitivity, but also more closely resembles flotation. Other advantages of the bubble pick-up method are that: (a) the apparatus can be easily assembled, (b) the mineral sample is conventionally prepared and requires no polishing, and (c) the test procedure is relatively simple.

The testing procedure can be divided into five stages. The first stage consists of the following steps: (a) cleaning of the glassware and bubble holder with cleaning solution and rinsing with distilled water; (b) the addition of 200 ml distilled water and approximately 0.5 gm mineral particles into the beaker; (c) the adjustment to desired pH value of the solution; (d) the addition of predetermined amounts of flotation reagents into the water-mineral mix and conditioning for two minutes with either a motor-driven glass stirrer or with a glass rod.



BUBBLE pick-up equipment and method are inexpensive and simple to do.

Minerals used for all our tests not only were closely screened but also were cleaned with dilute HCl and NaOH and rinsed many times with distilled water until the criterion—zero pick-up in distilled water—was attained. Naturally floatable minerals were similarly prepared until a constant low pick-up was made.

Microscopic Method

A method was devised which permitted a direct counting of the number of the pick-up particles, with or without the aid of a hand lens or microscope. This method is not limited by the index of refraction and size of the test mineral, and can be used with any apparatus described, including the extremely simple model shown. Figure above shows that the apparatus consists of a glass bubble holder and an air chamber and is operated like a medicine dropper.

The experimental procedure was divided into 8 stages. Stages 1 to 4 were similar to those described above. Referring to the drawing, the diagrams of stages 5 and 6 indicate that the mineral-bearing air bubble was drawn up into the bubble holder, which was then removed from the liquid before being discharged onto a watch glass.

The diagram of stage 8 indicates that the number of the pick-up particles was counted with a microscope. Stage 7, drying, was necessary only when the liquid interfered with the counting, such as with minerals having an index of refraction close to that of water.

Results of a quantitative bubble pick-up test can be expressed in terms of "number of pick-up particles" or "bubble load" and "bubble pick-up index."

The former is self-explanatory, and the latter is proposed for the purpose of canceling the idiosyncrasies of the bubble holder and mineral particles employed. For example, tests show that the number of pick-up particles varies not only with the size of bubble but also with the size of particles. The same data when calculated and plotted as bubble pick-up indices, are roughly independent of the sizes of the air bubbles and the mineral particles.

The bubble pick-up indices were calculated from the following equation:

$$PI = \frac{(p_n)\,100}{(p)} \qquad (1)$$

in which PI and p_n are respectively the pick-up index and the number of pick-up particles under any test conditions; and p is the maximum bubble load of the same mineral under optimum flotation conditions, and is considered as a practical standard of 100% pick-up.

The pick-up index of a mineral in presence of more than one flotation reagent represents only the combined effect but not the individual influence of the reagents. This is also true for naturally floatable minerals in presence of even only one flotation reagent.

The results of such tests can be more readily interpreted by means of "bubble pick-up coefficient," a term coined to denote the difference between the bubble pick-up index of mineral particles in a liquid and that of the same mineral-liquid mixture plus a chemical reagent at the same pH value.

For example, the difference between the pick-up index of a naturally floatable bituminous coal in a solution of water and an oily collector, and that of the same coal in water alone is a bubble pick-up coefficient.

Dr. Sun is associate professor of mineral preparation, Pennsylvania State University, University Park, Pa., and Mr. Troxell was a student at Pennsylvania State at the time this article was written.

TRAINING CLASS for supervisors (left) and 5-minute talks by foreman to workers (right) are parts of plan.

Ray Mines' Safety Plan Pays Off

ALLEN D. LOOK

M. L. WILLIAMS

CUTTING INJURY RATE from 40.90 to 11.71 per million man hours, lost time accidents from 97 to 25 and compensation from $64,000 to $9,000 per year in the first three years is ample proof of the excellence of the safety program at Ray Mines Division of Kennecott Copper Corp.

A so-called Master Safety Plan—put into effect in 1952 as the latest refinement of a 40-year effort—aims at developing and maintaining a strong safety awareness in all employees. It covers the entire operation of mine, railroad, concentrator, shops and auxiliary installations at Ray and Hayden, Ariz.

The plan is based on six aspects of safety:

Training
Publicity
Safety committees
Inspections
Investigations
Statistical records.

Initial training in safety is given to all supervisors and maintenance of a high state of training is emphasized. Each foreman is responsible not only for training his men but also for giving them a five-minute safety talk each week. Program is publicized through signs, notices on bulletin boards, plant publications, motion pictures and safety contests. Safety committees are organized on three levels to aid the program. Inspections are made periodically by committees and safety engineer. Each accident is investigated and reported, while carefully kept accident statistics guide the program.

Developing the master plan began with a careful study of factors affecting any safety program. Among the elements considered were:

Communications (meetings, publications, suggestions, posters, etc.)

Record keeping (costs, statistics, personnel, etc.)

Company policy (rules and regulations, attitude toward safety)

Union participation

Training (induction, safety, rules book, etc.)

In addition the plan was thoroughly discussed with top officials and supervisors. The result is a program that "keeps the pressure on" and permits changes as experience requires.

Training

Training starts with the supervisors. It involves as initial formal safety course for all supervisors (see below).

Supervisors Get Formal Safety Course

INITIATION OF NEW PROGRAM started with a 4-week safety training course for all supervisors including top level officials. Using conference method with 15-man groups, two-hour sessions were held during working hours on every other day, Monday through Saturday, for a total of 24 hours.

Conferences were led by trained staff under direction of supervisor of training and personnel coordinator. They were held in a well equipped classroom and many visual and audio-visual aids were used (see photo above).

Program was as follows:

CLASS	SUBJECT
1	A survey of accident records. National-State-Mining Industry and Ray Mines Division. (Designed to sell the need for safety concentration.)
2	Accident investigation.
3	Hazards—how to recognize them and guard against them (guards, signs, etc).
4	Protective clothing and its value in safety.
5	Good housekeeping and its role in accident prevention.
6-7	Human factors in safety.
8-9	The foreman's own master safety plan. Designed to help the foreman
10-11	How to give a safety talk—pointers and practice on giving a weekly 5-minute safety talk.
12	General discussion to review progress and answer questions.

Messrs. Look and Williams are with the U. S. Bureau of Mines and this article has been adapted from Information Circular 7772, March 1957. Kennecott Copper Corp. furnished illustrations.

It is followed up by including safety topics at all supervisors conferences, having special safety conferences when necessary and holding periodic safety refresher courses.

Employee training begins with an interview between the plant safety engineer and the new employee. During the interview the new employee is made aware of the company policy toward safety and he is urged to participate personally in the program by submitting safety suggestions and by talks with his foreman. He is also told what safety clothing he is required to wear on the job and why. In addition to being told where he can obtain these items he is given a printed list.

Before a new or transferred employee begins his assigned work he is given a safety instruction talk by his foreman. One month after starting work each employee is given a follow-up indoctrination by the safety engineer.

Education continues as each foreman is required to give employees under his supervision a five-minute safety talk at least once a week. He may select his own subject material or he can readily obtain assistance and advice from the safety engineer. To assist the foreman further in planning and conducting the weekly talks, a growing library of suitable safety talks and various visual aids is available.

As a further aid a "Guide for Preparation of Safety Talks" was prepared (see inset). For special purposes, members of the safety department staff are prepared to assist the foreman at these meetings. The foreman submits a weekly report of safety talks to his department head who in turn submits a composite report to the plant superintendent for all foremen under his jurisdiction.

Publicity

To further maintain an attitude of safety awareness, the aim and progress of the program are publicized through several mediums.

Safety record boards for each department and subdepartment are installed at strategic locations. The boards are provided with racks to hold various printed handouts, such as the monthly safety bulletin, which further publicizes the safety records and achievements of the various departments. Interest in the bulletin boards is maintained by frequent changes in the subject matter.

Employees' families and others in the community are informed of safety matters through the showing of sound films exhibited in the local theaters, schools and various service clubs.

Two interdepartmental safety contests are being used. The employees are divided into three groups of approximately equal size. When a group works 30 consecutive days without a lost-time industrial dsability, each member of the group is mailed two tickets to the local theater with a covering letter from the general manager.

An annual contest was started January 1, 1956, in which the same three groups compete. Each group has a par which is its own average frequency for the preceding 3 years. The group that makes the greatest percentage improvement over its own par is the winner. Employees in the winning group are given a suitable token award, and with their families, are guests of the company at a picnic or other gathering.

An improved accident record and any other outstanding safety effort made by a department or individual is promptly recognized by management in the form of special awards or congratulatory letters and is publicized in the monthly safety bulletin.

Safety Committees

To insure a free flow of safety communications between the employee and management there are three types of committees: The department committee, the supervisors' committee, and the plant safety committee.

The department committee is composed of one representative from each unit within the department. The department head serves as permanent chairman, and the plant safety engineer serves as the recording secretary. Except for the chairman and the recording secretary, membership in this committee is changed by staggered 3-month rotation. The department committees handle all safety problems within their respective departments unless the necessary action requires the cooperation of another department or an unusually large expenditure, in which case the problem is referred through the chairman's report to the supervisors' committee. Meetings are held monthly and a report is submitted.

The supervisors' committee is a permanent committee made up of representatives of top management, heads of departments, and the safety engineer. In operation this committee reviews suggestions and any matters that cannot be solved on a departmental level and initiates remedial actions when necessary. The committee is also responsible for initating and administering all safety contests with the aid of the plant safety committees. Periodically the plant safety records and accident analyses are reviewed. Meetings are held monthly and a report prepared to show action taken on safety suggestions.

The plant safety committee at the Ray and Hayden plants is composed of one member from each labor organization and the plant safety engineer. These committees conduct monthly formal over-all plant-safety inspections at their respective plants then discuss their findings and pre-

Guide Helps to Prepare Five-Minute Talks

I. List ideas

A. Questions to stimulate ideas
1. Do we know any accidents connected with subject?
2. What are the related unsafe conditions?
3. What unsafe acts are related?
4. Do we have any pictures, models, or demonstrations to show?
5. Do we know any interesting story, experience, or joke connected with subject?

B. Other sources of ideas
1. Safety supervisor.
2. Newspaper.
3. Magazine.
4. Safety course material.
5. Safety library.

C. Variety of Ideas
1. Visual aids.
2. Anything you can read.
3. Related comparisons.
4. Personal experience.
5. Examples.
6. Statistics.
7. Humor.

II. Organize these ideas

A. Start off with need to improve.
1. Actual accident.
2. Statistics.
3. Personal experience.

B. End with a bang.
1. Review points made in talk.
2. Tell a story on main theme.
3. Ask for action.

III. Study outline

A. Review main points.
B. Review joke or story to make sure it's down pat.

IV. Rehearse once

A. Rehearse out loud to yourself.
B. To see if you know it.
C. To check time.

V. Notify men of time and place of talk, if possible, to insure full attendance

VI. Assemble men and give talk

VII. Report talk to department head

VIII. Survey needs for next talk

IX. Begin to gather ideas for next talk

Accident Report Used By Foremen Is Complete

Report filled out by _____ Date _____

Name _____ P. R. N. _____ Occupation _____

Location of accident _____ First Aid given _____

Occurred _____ Did injured complete shift? Yes ( ) No ( )
(hour) (date)

Was injured sent to hospital for treatment? Yes ( ) No ( )

Number of days lost _____

Description of accident _____

Witnesses _____

ANALYSIS OF ACCIDENT

Accident type	Injury location
( ) Struck by	( ) Head
( ) Struck against	( ) Chest
( ) Caught in between	( ) Shoulder
( ) Falls	( ) Back
( ) Lifting	( ) Abdomen
( ) Electric shock	( ) Arm
( ) Inhalation	( ) Hand
( ) Using hand tools	( ) Leg
( ) Machines or equipment	( ) Foot
( ) Falling or flying objects	( ) Eye
( ) Explosion	( ) Finger
( ) Burn	( ) .....
( )	

INJURY TYPE

( ) Abrasion (scratches)	( ) Burns
( ) Laceration (cuts)	( ) Eye injury
( ) Puncture	( ) Sprain, strain
( ) Skin irritations	( ) Contusion (bruises)
( ) Infection	( ) .....
( ) Fracture	

ANALYSIS OF THE CAUSE

Unsafe acts due to:

( ) Lack of instruction	( ) Inadequate or lack of guards
( ) Lack of concentration	( ) Poor housekeeping
( ) Lack of discipline	( ) Inadequate protective clothing
( ) Poor judgment	( ) Defective tools
( ) Physical condition	( ) Improper layout of building, racks, etc.
( ) Emotionally upset	( ) Poor light, ventilation, etc.
( ) Haste	( ) Defective machines or equipment
( ) Taking short cut	( ) Weather conditions
( ) Unnecessary exposure	( ) .....
( ) Lack of experience	

RESPONSIBILITY

( ) Employee ( ) Foreman ( ) Department head ( ) Safety foreman

( ) Other _____

Rule violation? _____ Rule No. _____

Violated by: _____

What action (will be) (could be) (has been) taken to prevent recurrence:

_____

_____ _____ _____
(Foreman) (Department head) (Safety foreman)

_____ _____
(Superintendent) (General manager)

pare suitable recommendations. The committees also assist in the investigation of all lost-time accidents. The committee members act as judges for the safety contests and aid in the over-all administration of the safety program.

Inspections

Formal inspection tours are made each month at the Ray plant and at the Hayden plant by the respective plant safety committees, and their recommendations are submitted to the supervisors' committee for action.

Informal inspections and contact trips are made by the safety engineer at frequent intervals, each work area being visited at least once a week and more generally several times a week.

Informal departmental inspections are also made by individual department committee members; that is, the truck shop representative inspects the truck shop; the machine representative inspects the machine shop, etc. Suggestions and recommendations are brought together in the regular monthly meeting of the representatives as members of the department safety committee.

Investigations

Supervisors investigate all accidents involving workmen under their jurisdiction and submit a formal report that details the accident, its cause, responsibility and recommendations. (See inset.)

All lost-time or potential lost-time accidents are investigated by the plant safety engineer, assisted by the plant safety committee. The safety engineer submits a formal narrative report with recommendations attached to the supervisor's accident report. All such investigative reports are routed through the superintendent and general manager before becoming part of the permanent records.

Statistics

The effectiveness of a safety program is best indicated in the accident record, and a true picture can be obtained only by complete and honest records. In this respect the management of the Ray Mines Division appears determined to present such a true picture. American Standards Association Standard No. Z16.1-1954 is rigidly followed in the interpretaton of cases to determine whether they are recordable in statistics for calculating frequency and severity. If a case is not recordable under the standard, but the State Industrial Commission

MONTHLY mimeographed pamphlet of 15 to 20 pages has lively, entertaining tone that boosts interest in program.

awards compensation, the compensation awarded is still included in the total compensation costs.

Individual accident reports are prepared in detail by the foreman on the job as soon as practicable following the accident. From these individual reports, monthly and annual reports are prepared.

The annual safety report submitted to management is complete and concise. The report presents a true and graphic accounting of the progress of the safety plan and depicts the safety picture from two angles—(1) A comprehensive statistical analysis, and (2) a cost analysis.

Library Stocks a Number of Safety Aids

Aim: To make available to all foremen and supervisors a lending library of safety aids and safety posters.

Illustrated safety talks:

1. Why Accident Prevention (2 copies).
2. Shovels, Cranes, Draglines (2 copies).
3. Personal Protective Equipment (2 copies).

Safety graphs:

1. How to lift.
2. Bench and Stand Grinders.
4. Wearing Goggles (3 copies).
5. Plant Housekeeping.
9. Common Hand Tools.
11. Toe Protection.
14. Only a Scratch.
15. Wanted, Safe Workers.
16. Falls.
17. Does Your Accident Show.
18. My Aching Back.

Five-minute safety talks:*

Book No. 1 (35 copies)

1. General.
2. Personal Behavior.
3. Personal Protective Equipment.
4. Housekeeping and Sanitation.
5. Fire Protection.
6. Material Handling.
7. Control of Machine Hazards.
8. Working at Elevations.
9. Chemical and Solvent Hazards.
10. Storage of Materials.
11. Miscellaneous.

Book No. 2 (5 copies)

1. General.
2. Personal Behavior.
3. First Aid and Health.
4. Personal Protective Equipment.
5. Housekeeping.
6. Fire.
7. Material Handling and Storage.
8. Falls.
9. Machinery.
10. Chemicals and Solvents.
11. Hand and Power Tools.

Book No. 3 (5 copies)

1. It's Up To Us.
2. Dress for Safety.
3. Keep It Clean.
4. In Case of Accident.
5. Fire.
6. Hand Tools.
7. Portable Power Tools.
8. Job Hints.
9. Take a Tip.
10. On Your Own Time.

*NOTE: For each subject listed in the "Five Minute Safety Talk" books, we have several applicable safety posters available.

List Tells Men What Specific Safety Clothing Is Available

No. 2 Mine (from Mine Tool Room):

Leather Gloves	Deferred charge[1]
Rubber gloves	Do.
Bulldog goggles	Do.
Plastic goggles	Do.
Type "C" green goggles	Do.
Rubber boots (for temporary work)	Do.
Rubber boots (for personal use)	Personal charge[2]
Leggings	Deferred charge
Safety belts	Do.
Toe guards	Do.
Shin guards	Do.
Respirators	Do.
Lamp belts	Personal charge
Hard hats	Do.
Safety glasses	Deferred (for slusher operator) Personal (for others)
Plastic goggles	Deferred charge

Open Pit (from Pit Office):

Rubber gloves	Deferred charge
Leather gloves	Do.
Respirators	Do.
Plastic goggles	Do.
Safety glasses	Personal charge
Hard hats	Do.

Mechanical Department (from Master Mechanics Office):

Welding goggles	Deferred charge
Plastic goggles	Do.
Welder hoods	Do.
Welders sleeves	Do.
Welders aprons	Do.
Welders gloves	Do.
Leather glooves	Personal charge
Rubber gloves	Do.
Hard hats	Do.

Electrical Department (from Electrical Shop):

Respirators	Deferred charge
Leather gloves	Do.
Rubber gloves	Do.
Safety belts	Do.
Plastic goggles	Do.
Hard hats	Personal charge
Safety glasses	Do.

General Surface (from Framing Shed):

Respirators	Deferred charge
Rubber gloves	Do.
Plastic goggles	Do.
Hard hats	Personal charge
Snake bite kits	Deferred charge

Engineering Department (from Engineering Office):

Respirators	Deferred charge
Hard hats	Personal charge
Safety glasses	Do.

General Information

Prescription ground glasses can be obtained by having an eye examination by Dr. Karl Hoefest, who is in Ray every Wednesday between the hours of 10:00 a.m. and 5:00 p.m. at the K. of P. Hall. Safety shoes can be purchased at any of the shoe stores in Ray at cost plus 10 percent.

1) Deferred charge means that items are checked out to employees. If these items are worn out and reutrned, there is no charge for replacement. If the deferred charge item is not returned upon termination, the price is deducted from the final pay check.

2) Personal charge means that the item is made available at company cost. Replacement of such items is not furnished but must be purchased just the same as the original item.

TCI MODERNIZED ITS HAULAGEWAYS through systematic engineering studies and planned correction of faults.

NEARLY ALL HAND LABOR has been eliminated in constructing these modern haulageways. See text for details.

How TCI Improved Underground

L. H. JOHNSON

IN SEVEN YEARS, Tennessee Coal & Iron Div. of United States Steel Corp. reduced haulage accidents 66% and increased haulage capacity 59%. In 1949, haulage capacity limited output from individual ore mines to 1100 tons per shift. Today the same mines produce 1400 tons per shift—and there is a reserve haulage capacity of 25%. These improvements did not just happen. They were the result of careful, systematic engineering studies of the haulage system and planned correction of faults disclosed.

Early engineering studies revealed a number of faults, such as: passing points improperly spaced; derails not located where needed; manually operated block signals not effective; hand-operation of switches forced too much starting and stopping of trips; rails used too light; rail alignment and grade could be improved. Closely coupled with these findings was the conclusion that large size of haulage system made it difficult to maintain good track.

First step to overcome these difficulties was to write standard specifications covering construction and maintenance of underground track. A project engineer is assigned responsibility for developing and maintaining standard track practice specifications. These are revised periodically and distributed to all concerned. All construction and maintenance is done in accordance with these specifications. Particular emphasis is placed on clearance, grade, tamping, drainage, alignment, gage and elevation on curves.

Efficient, economical track haulage depends on trained personnel, suitable rolling stock, adequate power, efficient signalling and dispatching and good track. TCI tries to integrate all of these for maximum return from dual standpoints of safety and lower operating costs.

Mr. Johnson is assistant general superintendent, ore mines and quarries, Tennessee Coal & Iron Div., United States Steel Corp., Fairfield, Ala. Article is based upon a presentation before the 1957 Annual Meeting of the AIME in New Orleans, Feb. 1957.

Good Track Essential

Foundation of a successful track haulage system is good track. There are 147 miles of track in TCI's operating mines. In ore mines, average haul distance is 1.7 miles, longest haul 2.3 miles. In coal mines, average haul is 3.2 miles, with longest haul more than 5 miles. In both cases, track grades are limited to plus or minus 6%. It has been found that for TCI, good track consists of heavy rails laid on treated wooden ties with good sub-grade, substantial ballast and welded rail joints.

Before standardization of haulage system was inaugurated, all track construction was done by hand labor. Coarse ballast and fill consisted then as it does now, of loose broken ore or rock. This was hand loaded on material cars and hand spread at construction site.

Today, nearly all hand labor has been eliminated. Mechanical loaders and bulldozers, electric or diesel, load and distribute coarse sub-grade material. Bulldozers level loose ballast to sub-grade elevation.

Ballast distribution cars are made in local mine shops. They have drop bottoms and adjustable feed openings. Ballast is loaded directly into cars from trucks. Cars are hauled over newly laid track with bottom doors set to distribute ballast in amounts required.

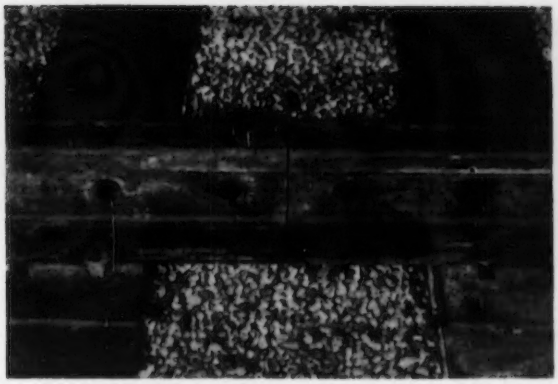
Each track laying crew has its own fully equipped, specially constructed work car. Equipment includes all power and hand tools crew will need and a 105-cfm compressor. About 200 ft. of new track is laid at a time and joined by conventional splice bars. After track has been in service for some time, a welding crew removes and salvages splice bars one joint at a time, and welds the joints.

Adopt Heavier Rail, Welded Joints

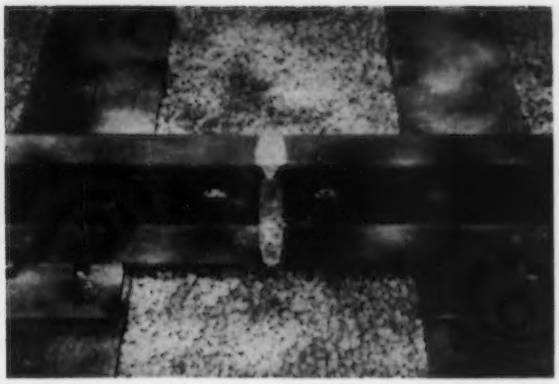
Haulage studies revealed that standard 60-lb ASCE 6040 rail section was unable to withstand loads imposed by heavy traffic of locomotives and mine cars. Resulting derailments destroyed splice bars and electrical bonds joining rail sections. This cut down on efficiency of electrical return through rail. In addition, it was the consensus that as rolling stock wore out it would be replaced with bigger cars and heavier locomotives. Result was adoption of 90-lb ARA-A 9020 rail section for mainline track.

Faults encountered with bonding practice led to preliminary discussions on welding track joints. Welded track provides a continuous metallic cross-section for electrical current flow, when rail is used as electrical return as at TCI. Such a section makes more current available for use of locomotives and other equipment and considerable savings in power are realized.

In addition to efficient electrical transmission, welded track provides continuous surface, so traffic can proceed safely at higher speeds. There is



MAIN-LINE RAILS are butted and prepared for welding. TCI adopted 90-lb ARA-A 9020 rail sections for main haulageways.



WELDED RAIL JOINTS resulted in appreciable savings in track installation and maintenance. Bonding losses were cut.

Haulage

no traction loss at joints. Therefore, sand consumption is lower, rail life is longer and fewer locomotive-wheel tires need be replaced.

Prior to adopting welded track at TCI, the move was considered for several years and several trial installations made. One of these was made specifically in an attempt to overcome loss of electric power due to broken or loose bonds and to cut down on costly, and frequently inadequate, maintenance of splice-bar joints. Savings of 75% were indicated on initial cost, plus subsequent reduction of 75% in joint maintenance costs. On the basis of this and other test installations, practice of welding rail joints was adopted in ore mines. Since taking this move about 5 years ago, 32,000 ft of completed, mainline track has been welded. Since track-welding was made standard in TCI's coal mines, about one year ago, some 18,000 ft of completed track has been welded.

Since welded track is a permanent type installation, it is planned for main line haulage only. So far, welding of joints on new haulage, extensions and active haulages has been accomplished without interrupting production.

Secondary haulage track is temporary, 60-lb rail seems heavy enough. It is joined with splice bars and bonded with 6/0 trolley wire or scrap shuttle car cable bronze-welded to track through use of a fusion welding cartridge and mold.

Rolling Stock

At present, TCI mines are using 117 locomotives. These are equipped with air-brakes, manually operated brakes, air operated trolley stands and air-feed sanders. The newest are powered with motors of either 90 or 120 hp each. Two-man motor crew rides in end-located armored cockpit. All locomotives carry rerailers.

Each mine locomotive is equipped with a radio-telephone, powered by trolley voltage and using trolley wire as carrier for the signal. Radio-telephone instruments at dispatcher's station permit constant contact between motor operator and dispatcher.

Rubber cushioned draft gear has been under test for some time. Tests show that use of this type gear, where practicable, will be advantageous.

TCI uses some 3,530 steel mine cars. Newer cars are eight-wheel, double truck design, equipped with automatic rotary couplings. Car bodies are built of Man-ten and Cor-ten steel with a fillet at bottom and side joints to make car self-cleaning. Steels were chosen for their abrasion and corrosion resistance.

Extensive tests of rebuilt car wheels indicate 70% savings per year in cost of car wheels if worn wheels are rebuilt.

Mine jeeps are used by supervisors and engineers. They are also used on occasion to transport personnel over long haulage distances and to carry small maintenance parts and tools to equipment idled by breakdown. Jeeps are guided by dispatcher by means of radio-telephone and by block signals. They require no motorman and do not interfere with normal traffic.

Low flat cars and eight-wheel, double truck material cars are used.

Secondary handling of material is reduced to a minimum by marking each car with the mining section to which it will be hauled and by loading all material for one section on cars marked for that section.

All mainline haulage units operate over track completely controlled by automatic block signal systems. These are installed and coordinated to allow only one locomotive in any one block. Motormen operate trips by signal indications without dismounting and without stopping unless track ahead is occupied. There is less delay, less starting and stopping of trips and safer operation than can be obtained with any other type of transportation control. It is also felt that in highly mechanized mines mechanical loaders can be kept supplied efficiently with empty cars only if traffic is controlled through use of automatic block signals.

Passing points are located on basis of time studies. They are placed so haulage times from point to point are as nearly equal as possible. At passing points, loaded trips take main line, empties take to siding. Switch alignment is arranged so no switch throwing is required. This is usually accomplished through use of spring split-switches. Wherever feasible, passing points on main haulages are equipped with automatic electric switches. Switch alignment can be changed, if necessary, by using a manual switch throw.

Safety First, a Way of Life

At TCI "Safety First" is not just a motto; it is a way of life. Latest developments in control and safety devices and newest methods are constantly being incorporated into underground haulage systems. Safe, economical and efficient haulage requires adequate engineering studies followed by formulation of specifications based on them. When specifications become standard and are rigidly followed, improved cost, safety and productive capacity become apparent. TCI has proved this through use of welded rails, automatic block signals, switches and derails, mechanized construction and improved rolling stock. Haulage accidents were reduced 66%, and output was increased 35%, with a 25% haulage potential in reserve.

NEW COPPER FLOWSHEET for the Bagdad Copper Corp. was developed at this pilot plant in Arizona. FluoSolids reactor and Peabody scrubber are shown at right, calcine and scrubber thickeners are in foreground, and tank house appears at left.

Bagdad Reports Metallurgical Test Results On Copper Recovery Method

E. S. HOWELL

J. D. GROTHE

B. H. McLEOD

BAGDAD COPPER CORP. has for a long time been considering expansion of its mining and milling capacity, and assisted by Dorr-Oliver Inc. has been studying application of the Dorr-Oliver Roast[1]-Leach-Electrolytic Precipitation Process for recovering copper from its concentrates.

The Bagdad orebody is peculiar in that the proportion of oxide copper ore to sulphide ore is higher than in any of the other porphyry copper deposits being worked at present. In fact, there are about equal parts of the two ores with a fairly well defined boundary. Recently, large tonnages of ore have been indicated making it necessary to expand production to obtain the most economical recovery of copper.

Engineering & Mining Journal, March 1953, contains a good description by the management and staff of Bagdad Copper Corp. of the work as it was started. Since that time, tremendous strides have been taken to develop the mine with the aim of producing 10,000 tons of ore per day. The time is close when advantage must be taken of this development work and a plant constructed to process the concentrates and produce as a by-product sufficient sulphuric acid to leach copper from oxide ore which has been carefully segregated on various dumps.

Concentrate roasting followed by leaching and precipitation of copper by electrolysis, combined with regeneration of acid, is not in itself new;

Mr. Howell is pilot plant superintendent, Bagdad Copper Corp., Bagdad, Ariz.; Mr. Grothe is director of consulting engineering, Dorr-Oliver, Inc., Stamford, Conn.; and Mr. McLeod is metallurgical consultant, Stamford, Conn.

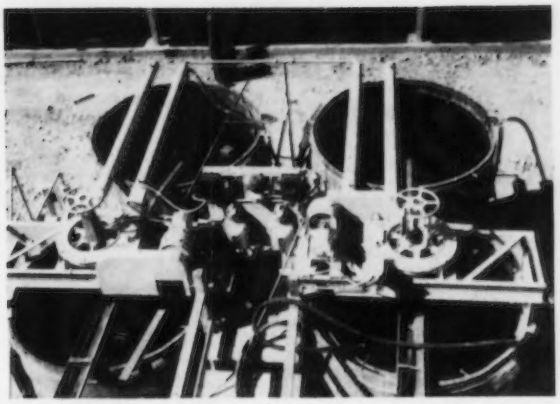
[1] Protected by U. S. Patent 2,783,141.

Operating Data Oct. 1, 1956 to Mar. 31, 1957

Metallurgical results	Average	High	Low
Cathode copper recovery	86.99 } per	89.53	83.35
Starting sheet scrap	1.59 } cent	2.08	1.27
Sponge copper	7.62 } 96.20	11.22	6.04
Tank house discard	0.25	0.31	0.17
Tailings	2.31	2.66	1.94
Unaccounted for	1.24	4.20	0.50
Current efficiency	88.5	91.4	78.9
DC kwh per pound of cathode copper	0.861	0.896	0.823

Reactor feed	High	Low
Copper	33.36%	23.41%
Iron	25.89	21.47
Sulphur	27.54	25.85
Insol	18.04	13.87
Leached residue		
Solids	1.89%	0.95%
Solution	0.39	0.02

Tank house		
Pregnant solution	**High**	**Low**
Copper	49.37 gpl	44.0 gpl
Iron	3.0	1.8
H_2SO_4	43.5	35.2
Discard solution		
Copper	0.22 gpl	0.12 gpl
H_2SO_4	119.0	109.9



PRODUCTS FROM GAS SCRUBBER and calcine quench tank go to these four thickeners and cooling tanks in roasting section.

LEAD BASKETS containing scrap starting sheets are hung in spaces at ends of electrolytic cells. See text p 89 for explanation.

certainly it is not new to Bagdad. The same process was suggested and investigated by the company prior to 1930. This early attempt, previously described in the American Electrochemical Society by Charles T. Baroch (June 1930), involved construction of a pilot plant complete with hearth roaster, leaching and washing equipment and tank house to produce cathode copper. Attempts both before and after this endeavor ended in failure due to the difficulty of controlling solubility of iron.

Iron Control Is Problem

Development of fluidized roasting techniques gave rise to hope that the earlier failures to control iron solubility could be overcome and that the project could be successful. The following description of a fluidized bed indicates the principles of operation within the reactor itself.

Solids fluidization is the partial suspension of solid particles in an upward moving stream of gas. When so partially suspended, the solids are said to be fluidized because they then behave much like a liquid. The mass is boiling and bubbling, similar to boiling water. It will seek its own level, like a liquid; will overflow a weir or transfer pipe; and will have an apparent density much lighter than that of solid particles, either singly or as a settled mass. It will have a uniform consistency as to particle size, chemical composition and temperature. The fluidized mass will exert hydrostatic head, and pressure taps will show differential pressures between points at various depths in the bed. The top of the fluidized mass although irregular, like the surface of a boiling liquid, has a sharp line of demarcation from the gas above. In fact, the Dorrco FluoSolids[2] system of fluidized roasting makes it possible, once the correct temperature and air requirements are established, to maintain these conditions with insignificant variations.

J. C. LINCOLN, president of Bagdad, pulls first commercial copper cathode.

After experimental work by Dorr-Oliver at their Westport, Conn., laboratory spread over several years, Bagdad Copper Corp. engaged the former to design and supply a pilot plant of a scale sufficient to prove out the details of the method, to develop basic information about probable operating costs and to train local personnel in the proper operation of such a plant.

The pilot plant was designed to treat five tons per day of copper concentrates from the Bagdad mill. In addition, 600 to 750 lb per day of cement copper from the dump leaching is added to the tonnage making a total output of 3,250 lb of copper per day. Concentrates assay approximately 26% copper, 26% iron and 31% sulphur.

Since May 1956, the plant has been in almost continuous operation with the exception of occasional shutdowns for changes and improvements.

As in all pilot plants, some difficulties were encountered because of the small scale of the plant. For example, pumps and pipe lines cannot be scaled to the correct size. Far more difficulties were experienced with conditions of this kind than with any of the major items of equipment. Probably few of the troubles would have occurred in a plant of greater scale. In particular, the counter-current decantation plant was far from being as efficient as is known to be possible from practice on a large scale. However, piloting this part of the plant was hardly necessary.

The Bagdad orebody consists of oxide ore in addition to sulphide ore and the Dorrco-Roast-Leach-Precipitation Process has been proven to be ideally suited for treatment of concentrates produced from sulphide ore. In the roasting process and in the electrolytic precipitation of copper an average of 1.7 lb of sulphuric acid is produced for every pound of copper precipitated and this acid is used to leach the soluble copper from ore on the oxide dump.

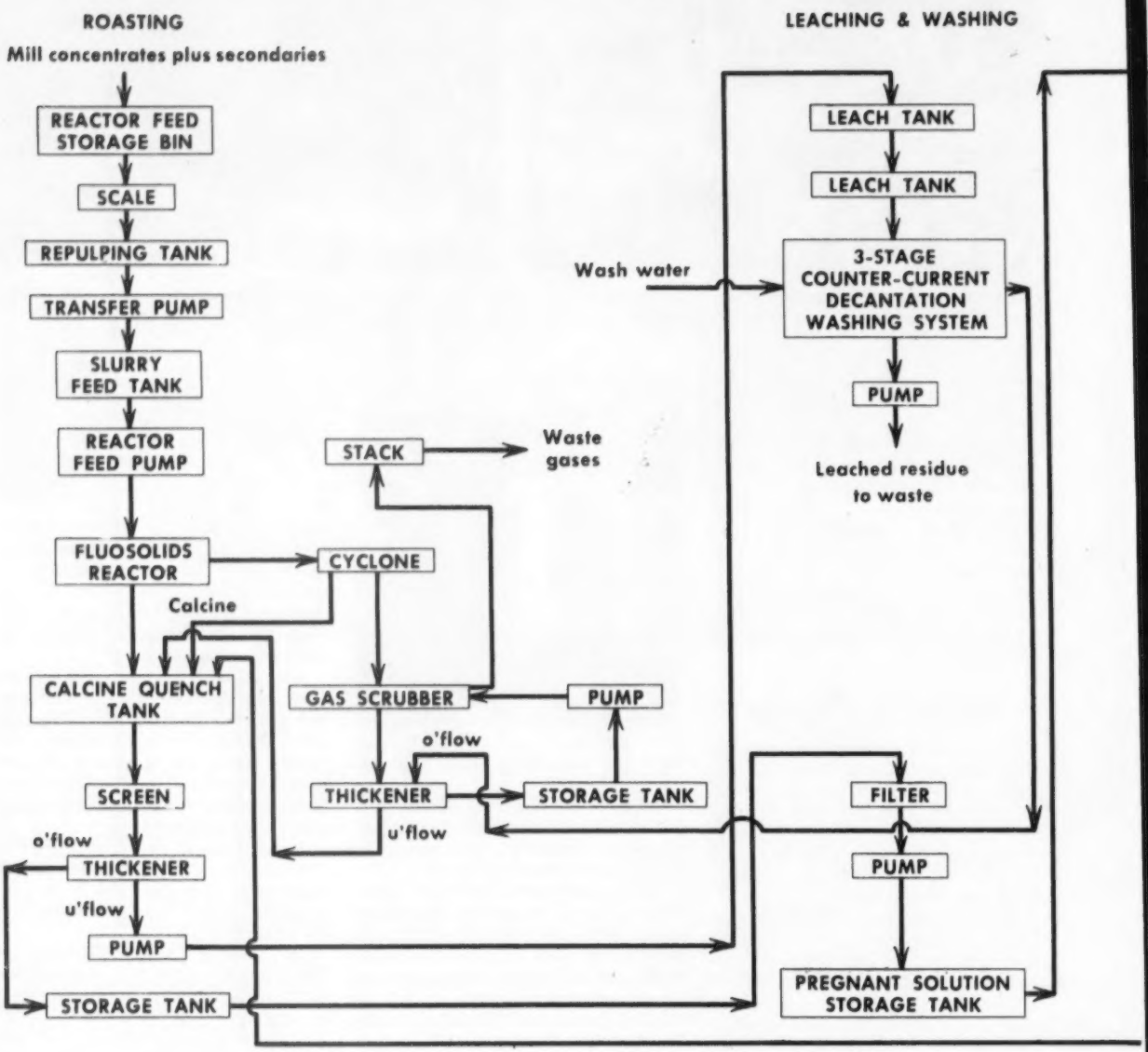
In roasting these concentrates, which are predominately chalcopyrite, sufficient excess air is blown through the fluidized bed to convert copper sulphide to water soluble copper sulphate. Thus the acid required to solubilize copper is substantially reduced and an equivalent quantity of sulphuric acid liberated during electrolysis.

With this in mind, the roasting temperature must be accurately regulated; if too low, iron will be solubilized, and if too high, some of the copper will be rendered insoluble. An automatically controlled water spray inside the reactor maintains temperature at the desired level. Under normal conditions, when feeding a slurry to the reactor, there is more than sufficient heat available from the oxidizing reactions to carry on combustion.

The Dorrco reactor is equipped with various feeding devices, necessary

[2] Dorrco and FluoSolids are registered trademarks of Dorr-Oliver Inc., Stamford, Conn.

FLOWSHEET OF ROASTING, LEACHING AND FOR BAGDAD COPPER CORP.,



auxiliary equipment, a cyclone for removing dust entrained in the roaster exit gases and a scrubber to remove fine dust from cyclone gases.

The reactor can operate under either positive or negative pressure and is equipped with instruments for measuring pressures and for controlling negative pressure, when the reactor is operating under that condition. Four thermocouples record temperatures at different points within the roaster, a fifth records the cyclone temperature, and a sixth records temperature of the scrubber discharge.

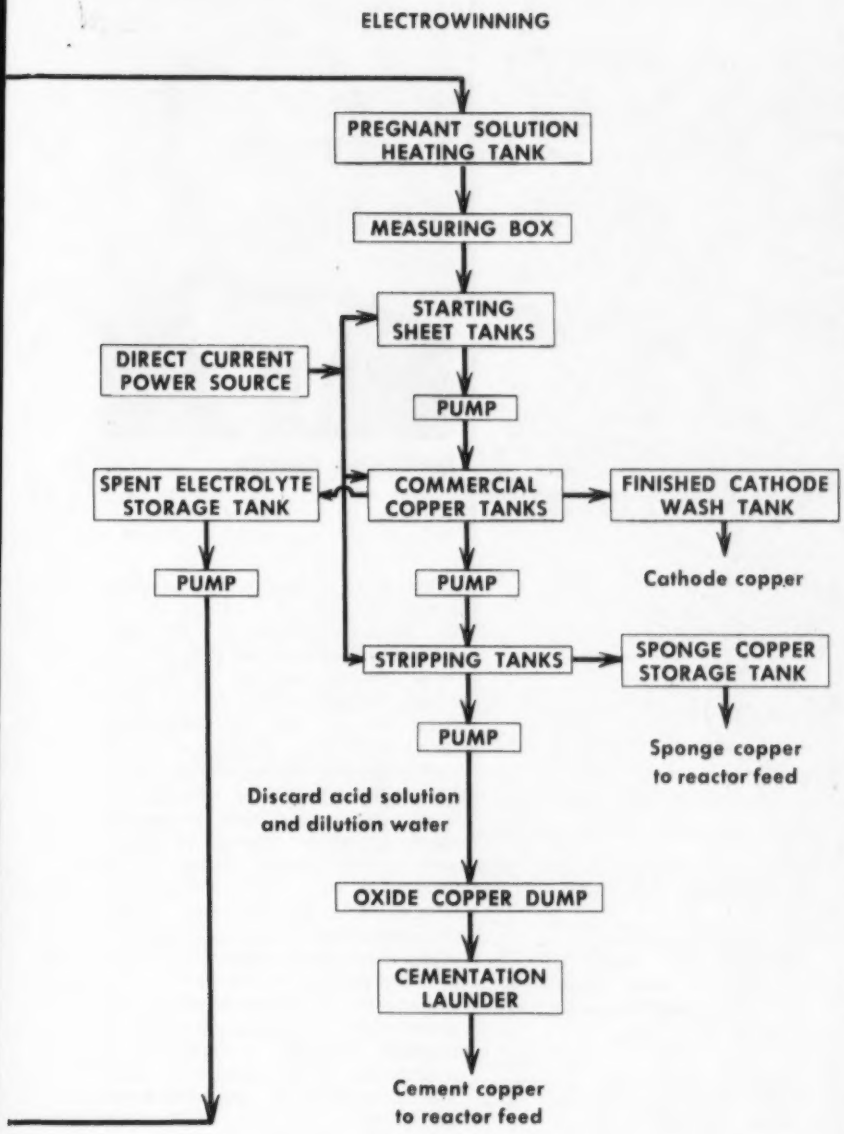
Concentrates are fed to the reactor either dry or as a slurry; the latter has proved to be more satisfactory during the months that the plant has been operated. At designed capacity ample heat is available to permit the roaster to be slurry fed.

In order to make the plant as flexible as possible and to change the flowsheet when desired, rubber hoses were used for transferring solutions and slurries. Changes were frequent and easily made. The attached flowsheet shows one arrangement which has been used for a long time. Recently a change was made that utilized one of the thickeners in the quench and cooling system making a four-stage CCD and which had the advantage of losing less heat in the cold weather. This change resulted in a reduction of copper in the tailings solution and consequently in improved recovery.

There are 22 concrete lead-lined cells in the tank house. In the first two starting sheets are produced from pregnant solution using cold rolled copper blanks and insoluble anodes. There has been no difficulty in producing starting sheets from this solution.

Four blocks of four cells each reduce copper content to 5 to 6 gpl and

ELECTROLYTIC PROCESS
BAGDAD, ARIZ.



the remaining four cells strip the solution of copper down to 0.1 to 0.3 gpl. Sponge copper produced in the stripping section is returned to the reactor and becomes a circulating load. Spent solution returned to the leaching system is about half the volume of pregnant solution coming into the tank house and contains about half as much copper.

Stripped Solution Diluted

The stripped solution, which contains over 100 gpl H_2SO_4, is diluted to about 7.5 gpl and is sent to the oxide dump; solution coming off the dump goes to the iron launder. Precipitated cement copper is returned to the reactor.

In each electrolytic tank a space containing no electrodes was provided. This space was intended to be used for redissolving any low grade cathodes that might not be acceptable as cathode copper. However, analyses have shown that copper in the last commercial block is as pure as that in the first. The chief reason for this high purity is the absence of impurities in the concentrate and the discard of large quantities of solution to the dump, thus preventing any opportunity for build up.

Lead baskets are hung in the space at the end of the cells and filled with scrap starting sheets and edges from the starting sheet blanks. This waste is oxidized and dissolved by solutions in the cells. Starting sheets are straightened once and left in the tanks eight days.

In February of this year tests were carried out with the reactor operating at an average bed temperature of 1,297 deg F. Water solubility of copper in the calcines produced at this temperature was 62.4% of the total copper in the calcines. During this same period acid soluble copper averaged 97.4%.

In March the test was continued with the roasting temperature reduced to an average of 1,265 deg F. As a result water soluble copper in the calcines increased to 94.6% while acid soluble copper averaged 98.7%.

During the period of higher temperature iron solubility was low—only 2.01% of the total iron. Consequently the pregnant solution contained only 2.0 gpl total iron. During the low temperature period acid soluble iron was 3.66% of total iron.

Because of the changes that have been considered beneficial and that have been made average metallurgical results do not convey the information required, and figures given for ideal operation do little better. All of the details and conditions that correspond to such figures should also be reported.

Here Are Results

To compromise, the average metallurgical results are given for the last six months of operation and the monthly average high and low figures are tabulated together with them. See accompanying table.

The high average for the month and the low average for the month of the assays of the feed and solutions are also presented.

Assuming that sponge copper returned to the reactor will be precipitated electrolytically twice, the kwh requirement per pound is estimated to be 2.4. Therefore, to produce all copper as cathode copper requires 1.02 kwh dc per lb.

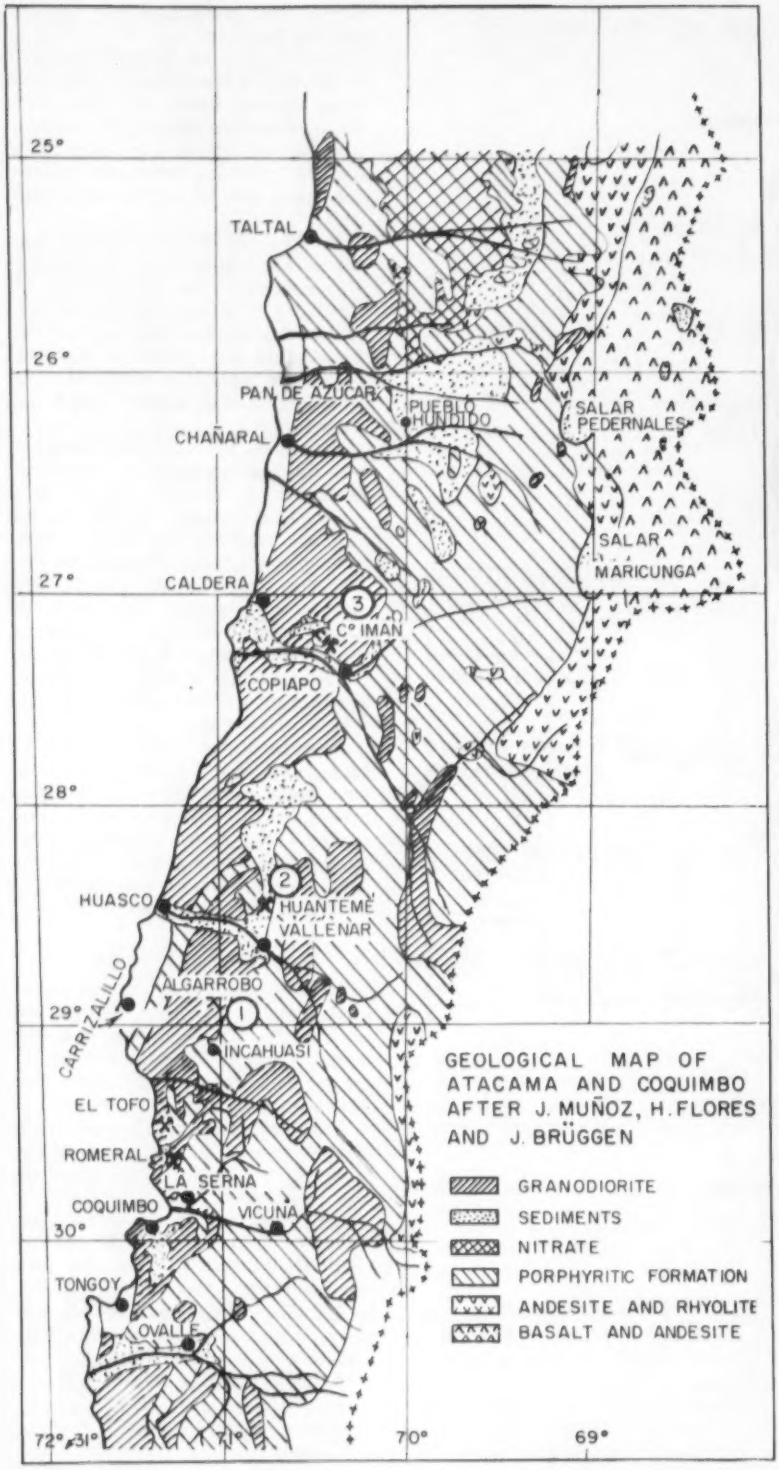
Cathodes assay as follows:

Copper	99.92%
Arsenic	0.001
Bismuth	0.00008
Antimony	0.0002
Molybdenum	Trace less than 0.0005

The authors express appreciation to Bagdad Copper Corp. for permission to publish this article and to the engineering and metallurgical staffs of both Bagdad and Dorr-Oliver for aid in collecting and preparing the data.

The Iron

FERNANDO BENITEZ



EXPLORATION ENGINEERS focus interest on iron ore deposits in this 400-mile section of Chile extending from north of Santiago to south of Antofagasta.

LEGEND

1. Chinchilla, Cantera, Algarrobito, Cachiyuyito, Yungay, Limari, Cruz de Canas, El Molle, Ojos de Agua, La Cobre, La Petaca, Cerro Negro, Tunilla, Pocitos, Algarrobo, Romerito, Estancilla, La Liga, La Hollada, Cortadera, Los Barros and Las Tazas.
2. Los Colorados, Chanar Quemado, Sositas and Huanteme.
3. Cerro Iman, La Liga, El Lunar, Fortuna, Cerro Negro Sur and Cerro Negro Norte.

CHILE is a long narrow country extending from Lat S 17 deg 10 min to S 56 deg, a distance of 2,625 miles. Its average width is less than 100 mi. It is 190 mi. wide at Antofogasta. Morphologically Chile can be divided from west to east into three subdivisions; the Coast Range, the Central or Longitudinal Valley and the Andes Mountains or Cordillera. This division is not distinct and clear throughout the length of the country. In certain sections the Central Valley is obliterated by spurs of the Cordillera that branch off to join the Coast Range.

In the Coast Range are found the oldest rocks in the country. These are gneisses, schists, micaceous slates, phyllites and quartzites. Some of these are strongly metamorphosed. They are probably Paleozoic or Mesozoic in age. In many places these older rocks are cut through by granodiorite intrusions.

Many of Chile's ore deposits are genetically related to these granodiorite batholiths and laccoliths that intruded during Cretaceous time, coincidentally with early folding and faulting of the Andes. The geology of Chile has not been mapped in detail and structures are so complex that it is extremely difficult to determine the exact age of even the main formations. Geologists with long experience in Chile differ widely on criteria to determine the age of the country's rocks.

Sr. Ing. Fernando Benitez is a consulting engineer in Santiago, Chile. His article represents 31 years of field work, since he first visited Algarrobo and the other iron mines south of Vallenar, Chile in 1926.

Mines of Chile

Though Chile possesses many high grade iron deposits, it is only recently that they have begun to be exploited systematically. In size these deposits cannot begin to compare with those of Lake Superior, Canada, Brazil or Venezuela. In iron content they compare favorably with the iron ores of Lake Superior.

El Tofo was one of Chile's largest iron ore deposits with 45 million tons of high grade ore. El Tofo was worked out in 1956 by Bethlehem Chile Iron Mines. This company has begun operations at Romeral (about 20-million tons) north of La Serena.

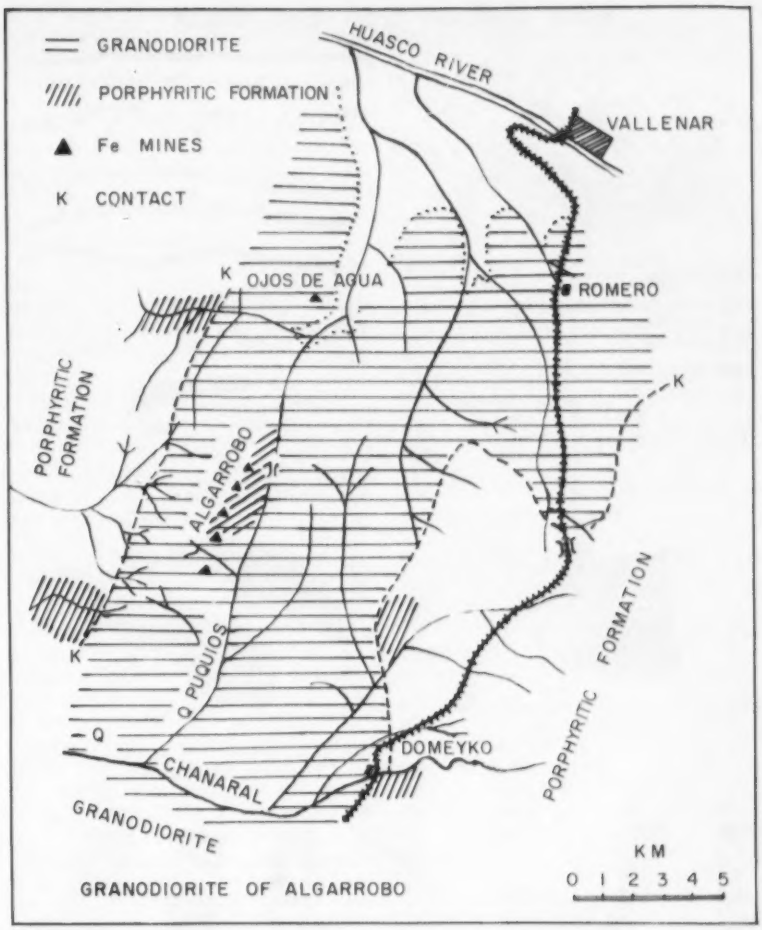
Algarrobo, south of Vallenar, belongs to a Dutch-German company and contains about 100-million tons of high grade ore. Total known reserves of high grade ore in Chile has been estimated at 182-million tons.

How this tonnage is distributed is shown in the following tabulation.

Mine	Probable Reserves (millions of tons)
El Tofo	Worked Out
Algarrobo	100
Romeral	20
Cerro Imán	6
El Lunar	2.5
Bandurrias	11.0
Los Colorados	3.0
Sositas	1.8
Huantemé	2.6
El Pleito	4.0
Fortuna (Talca)	1.4
Total	152.3

To these probable reserves some 30-million tons of possible ore would have to be added, for smaller mines and for those known but not yet fully developed or prospected. This brings the total ore figure to about 182,000,000 tons (metric). Average grade is 60%. This total does not include the large number of tons of low grade taconite ore at Relún, which are described on p 93.

These iron ore deposits in the provinces of Coquimbo and Atacama, extend north from Ovalle (Infiernillo Mine) to El Salado. They occupy a narrow belt running about South Southwest to North Northeast. According to the geologists Flores and Ruiz, who studied most of the deposits, their distribution is closely related to the main tectonic features of this region, especially with the axis of the Cretaceous folding and with the great granite batholiths of the Coast Range. This relation is clearly shown on the map by the position of the principal orebodies. Note how the orebodies flank the coastal batholith.



ALGARROBO DEPOSIT has probable reserves of 100-million tons. This is a detail geological map of the Atacama District (1) shown on general map on opposite page.

Composition of Iron Ores of Chile

Orebody	Fe %	Al_2O_3 %	SiO_2 %	Mn %	CaO %	P %	S %	H_2O
Algarrobo	64-68	0.2-1.6	1.5-7.0	0.12-0.25	0.35-	0.03-0.10	—	—
El Tofo	60	1.80	1.86	0.04	—	0.04	0.05	0.75
Relun	39	1.82	34.0	0.28	0.64	0.02	0.27	0.70
Lake Superior	58	2.23	7.7	0.71	0.54	0.10	0.06	—

Principal Iron Ore Deposits of Chile By Zones from North to South

Zone or Region	Deposit
Arauca Malleco	Relún
Talca	Los Toros
Ovalle	Infiernillo, El Dorado
La Serena	El Tofo, Romeral, Juan Soldado
Incahausi	Los Cristales, Cerro Negro, Tunillas, Pocitos
(3) Northern Group[1]	Cerro Imán, La Liga, El Lunar, Fortuna, Cerro Negro Norte and Cerro Negro Sur
(2) Vallenar[1]	Algarrobo, Sosita, Huantamé, Chañar Quemado, Los Colorados, Los Llanos.
(1) Atacama, from Huasco River to Incahausi	Chinchilla, Cantera, Algarrobito, Cachiyuyito, Yungay, Limarí, Cruz de Cañas, El Molle, Ojos de Agua, Romerito, Estancilla, La Liga, La Hoyada, La Cobre, La Petaca, Cerro Negro, Tunilla, Pocitos, Cortadera, Los Barros y Las Tazas (these last six known under the generic name of Cristales.)

[1]Numbers in parentheses refer to numbers in legend on opposite page.

How Chilean Iron Ore Occurs

FIG. 1—Geologic sketch of Algarrobito

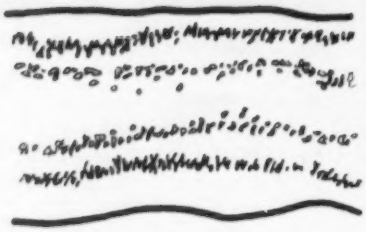


FIG. 3—Vein with banded symmetrical belts, Cachiyuyito. Outside bands: Apatite. Middle bands: Amphibole.

FIG. 4—Showing the upper portion of a hidden iron mass discovered by a drift. Algarrobo Mine.

FIG. 2—Cross section through an Algarrobito vein.

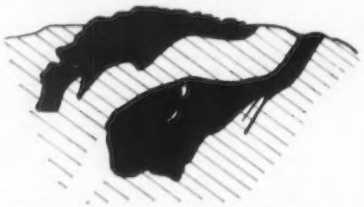


FIG. 5—Cross section through two iron masses in Algarrobo.

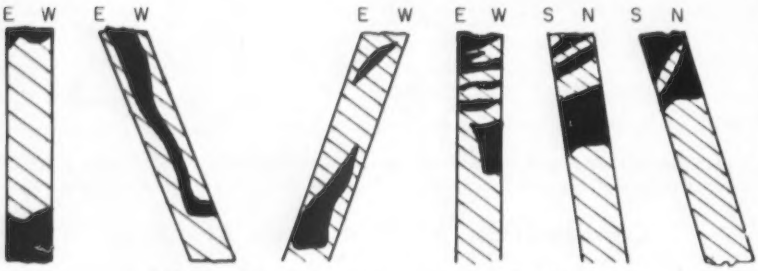


FIG. 6—Cross sections in some shaft of Cristales.

Southern Atacama Deposits Epigenetic

Most of the iron mines are found close to the contact between the granodiorite batholiths of the Coast Range and the Upper Jurassic porphyries. They are located within the intruded porphyries and are rarely in limestone or granodiorite itself.

Linneman, who investigated some 20 iron deposits in southern Atacama in 1918 and 1919, classified them as epigenetic, because all have many features in common, characteristics of this type of deposit. Taking into account observed patterns and post magmatic, pneumatolitic and hydrothermal processes that must have taken place after their differentiation, there is some question whether Linneman's classification is entirely satisfactory.

There is a close relation between iron deposits and apatite deposits that form an aureole around many of the iron orebodies. Sometimes the apatite deposits are of more economic importance than the iron, as at Ojos de Agua. The age of the iron deposits, in general, coincides with the end of the period of granodiorite intrusion. Texture of the rock is coarse. It is composed of plagioclase and hornblende grains with quartz in variable amounts and small quantities of microscopic apatite grains.

Linneman explains the genesis of the iron ore deposits of southern Atacama as follows: during intrusion of the granodiorite magma, there remained in depth a facies richer in hornblende and iron. In this way there was formed in the normal granodiorite a differentiation richer in quartz and very poor in hornblende. After crystallization of the granodiorite came the *magmatic* intrusion of hornblende, either coarse or fine-fractures whose strike is exactly the same as that of the granodiorite intrusions. In the majority of these deposits, the iron ore is not in direct contact with the granodiorite itself but there is an intermediate zone, several hundred meters thick, made up of hornblende, either coarse or fine-grained. In the neighborhood of some of these deposits there is found a whitish compact rock similar to an aplite; in some others these bodies are replaced by lenticular lenses of quartz, as for example, in Romerito and Cristales and especially in Molle and Cachiyuyito, where these quartz lenses are several hundred meters thick and one to two kilometers long. In Romerito the quartz lenses are irregularly spread within the hornblende mass that surrounds the iron deposits.

El Tofo Orebody Worked Out

Prof. Brüggen holds similar views as to the origin of El Tofo and Algarrobo, largest iron deposits found thus far in Chile, Brüggen says El Tofo orebody is within the contact zone between a granodiorite mass and a block of porphyry, which is really a "roof-pendant" that strikes north northeast. El Tofo orebody is in the western portion of the porphyry and its genesis is explained by a great segregation that took place in the granodiorite mass. Thus it has the same origin given by Linneman for the southern Atacama iron mines. Brüggen says it is very difficult to fix details of the intrusion of El Tofo orebody because later on gases and solutions penetrated the formation altering country rock to such an extent that its original form cannot be clearly established. Post mineral alteration resulted in formation of chlorite, impregnation of specularite and leaching, that ended in kaolinization.

In this case there is no sharp reparation between orebody and country rock but a gradual transition between the iron ore and green hornblende.

Algarrobo May Be Syngenetic

Algarrobo Mine is 28 miles southwest of Vallenar, 3,300 ft above sea level. It outcrops in a North—South direction along two hills known as Penoso and Algarrobo. Outcrops can be traced for about 2.5 miles. To the North and separated from the Algarrobo Hill by Nisñiles Canyon, is the much smaller Los Morritos Negros iron mine.

Algarrobo deposit was investigated by a Swedish geologist, P. Geijer. His

report is cited by Brüggen who quotes him as saying that rocks of the porphyritic roof are lavas of recent age, such as soda andesite, trachites, etc., which went through the granodiorite and must be considered as the iron carriers. If Geijer is correct, Algarrobo would have to be considered of syngenetic origin.

Northwest of Vallenar are several iron orebodies that were investigated carefully by C. Ruiz in 1941. Most important of these are Los Colorados, Chañar Quemado, Sositas and Huantamé. All are in metamorphic porphyries and near large masses of quartzites, like those described by Linneman. Some of them are several square miles in extent and up to 800 ft thick. These masses of hornblende and quartzite are derived from the porphyries by leaching and replacement. Primary ore mineral is magnetite.

Ruiz also studied the Copiapó iron deposits in 1942. These extend North Northeast about 13 miles. Starting with Cerro Imán six miles northwest of Copiapó, they are, from South to North, Cerro Imán, La Liga, El Lunar, Fortuna, Cerro Negro Sur and Cerro Negro Norte. This whole region corresponds to the contact between the great coastal granodiorite batholith and the Mesozoic sedimentary and effusive formation which was intensely metamorphosed by the granodiorite intrusion.

Cerro Imán Largest in Group

Cerro Imán is largest of the group. Its outcrop is an ellipse whose major axis is about 900 ft and whose width averages 250 ft. It is close to the contact between the granodiorite and metamorphosed porphyry. These rocks have been greatly altered by pneumatolitic metamorphism. Scapolite has changed to sericite and epidote, quartz, biotite and magnetite have been formed.

The orebody itself is formed almost entirely of magnetite, hence its name Cerro Imán or Magnetic Hill. Large hornblende crystals are cut through by magnetite, showing that the magnetite is the younger mineral.

La Liga orebodies have little economic importance. Some of them have irregular shapes. Others are veinlike. Most abundant country rock is the metamorphosed porphyry, but the iron orebodies are all within the amphibolite. This rock as well as the iron masses is cut through by many, thick diorite porphyry dikes. From this Ruiz concluded that between formation of the orebodies and intrusion of the dikes there must have been great tectonic movements.

El Lunar Mine, next in importance to El Imán, has a vein form and is very regular. It is cut through the middle by a recent major fault. El Lunar outcrops for about 1,500 ft with an average width of 25 ft. Rocks surrounding El Lunar are porphyries almost entirely metamorphosed to amphibolites. They are composed of amphibole, andesite, magnetite, epidote, titanite and a little biotite. Amphibole predominates.

El Lunar orebody itself is almost exclusively magnetite, with a little quartz, pyrite and chalcocite. By alteration these have given rise to limonite, covellite, chalcocite, azurite and malachite.

Fortuna, Cerro Negro Sur and Cerro Negro Norte, of little economic importance, are of great geologic interest. According to Ruiz, their paragenesis comprised three stages. In the first stage, amphibolite, apatite, scapolite and tourmaline were formed. Stage two is represented by magnetite and probably titanite. In the third and last stage, quartz replaced earlier minerals.

Bandurrias iron deposit, 13 mi. east of Castilla, south of Copiapó, was described by Prof. Flores. He considers this deposit in the zone between contact deposits and those formed by hydrothermal replacement. The region where this deposit is found is made up of a sedimentary formation, mainly limestones striking from North-South to Northeast, dipping 30 deg Northwest. The iron deposit conforms to this formation but the limestone in the neighborhood of the granodiorite has been strongly metamorphosed to marble and garnet bearing rock. Valuable minerals are chiefly magnetite and hematite, with small amounts of pyrite. The gangue is quartz and calcite.

Los Toros Mine is 95 mi. east of Talca, 7,300 ft above sea level. It has been classified by H. Flores as hydrothermal. It has the form of a lode 2000 ft long and 40 ft wide. Country rocks are metamorphic limestone and sandstone. West of the limestone is a large granodiorite massif, that has altered some limestone strata into garnet rock.

In the upper part of the deposit limestone is found. Magnetite and hematite occur at lower horizons with pyrite that increases with depth. Quartz is abundant.

Taconite Deposits for the Future

Relún deposits were discovered about 15 years ago. These are large, low grade taconite deposits in the Nahuelbute mountains some 25 mi. from Quidico, extending into the provinces of Arauco and Malleco. These deposits studied by Flores, are in the Coast Range in a zone of micaceous slates of doubtful age. Dip of these slates varies from horizontal to 10 to 15 deg. However, toward Contulmo, Capitán Pastene and Carahue, the beds dip steeply and are strongly folded. The iron beds strike N 10 deg E and faults striking East Northeast raise the blocks in the northern end of the formation. The iron bearing horizon is about 66 ft thick and interbedded with micaceous slates. It is made up of several bands in which iron-rich horizons alternate with others that are iron-poor but richer in quartz.

Under the microscope, ore shows fine granular magnetite and quartz. There is very little replacement of these minerals by hematite. Megascopically the ore shows banded texture. Flores believes that this deposit may be a concentration of magnetite on a beach by sea waves and currents. Some pyrite, observed locally, may come from a lower granite intrusion or from organic sulphur.

Most important zone thus far investigated is 9.5 mi. long and 5 mi. wide, about 48 sq mi. These deposits are large and their structure is relatively simple. Their geologic investigation should be easy. However, their low grade, 35 to 40% iron, makes them a reserve for the future when the high grade ores, over 60% iron, are exhausted.

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How to Select Your Conveyor Belt—Part 2

ROBERT E. SPOERL

IN PART 1 of this article we discussed three main problems of belt selection with a step by step solution to each. These were "How to Choose Correct Belt Size and Speed," "How to Determine Total Belt Horsepower" and "How to Calculate Belt Tension," Let's go to the next step.

How to Choose Carcass, Cover And Belt Grade

TO SELECT THE BELT which will deliver the greatest overall efficiency for all requirements, you must first consider these three basic elements:

1. Belt carcass: This is the body of the belt consisting of a varying number of rubber-impregnated fabric plies. The number of plies, type or style of fabric, and the grade of the rubber compounds impressed into the fabric, determine the strength and service life of the carcass.

2. Belt cover: This is the rubber envelope that protects the belt carcass. The service it will give you is determined by four factors:

a. thickness of its top, or carrying side
b. thickness of its bottom or pulley side
c. thickness of its edges
d. grade or quality of rubber used

3. Belt Grade: This is the specific brand of belting that you need for your particular job. To meet precisely the demands of your installations, these brands offer stepped variation in the strength, toughness, and wear-resistance of the cover, and in the quality of the rubber compounds used in the carcass.

Selecting the Carcass

Once we have calculated the total belt tension (*E&MJ*, May 1957), we can determine the belting fabric and the number of plies of which our belt must consist. Proper carcass determination must be based on the following requirements:

1. Construction must be strong enough to withstand the maximum tensions developed and thick enough to support the load between the idlers.

2. The carcass must have sufficient body to withstand the impact of the load when it is being fed onto the belt and when it is being carried.

3. The carcass must have sufficient crosswise flexibility to trough properly at all times. The belt must be thin enough to contact the horizontal idler roll so that it trains perfectly when empty. However, the belt must not be so thin as to crease lengthwise between the inclined and horizontal idler rolls when loaded.

To meet these requirements we must consider five carcass selection factors: maximum permissible working tension of the fabric; suitability of the fabric to various operating conditions; the minimum number of plies to support the load; the maximum number of plies permissible for proper troughing; and the diameter of the pulleys. These factors are interrelated and interdependent. And they will therefore require cross-comparison throughout the carcass determination procedure. Before beginning our examination of the procedures, let's look at each of the carcass selection factors and its relationship to the others:

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Part 1 of this article appeared in the May 1957 issue.

Maximum Permissible Working Tensions

The maximum permissible working tension is the stress which a single ply of fabric can withstand without ill effect. It is measured in pounds per inch of belt width: that is, a ply for a 30-in.-wide belt can withstand 30 times the maximum permissible working tension for that specific fabric.

Maximum permissible working tensions for different brands of belts can be obtained from the various manufacturers. Maximum permissible working tensions for "U.S." belting fabrics are given in Table 11 for illustration. Two values are listed. Values under "Condition A" apply to belts for conveyors which include these advanced features: mechanical feeders to govern feed rate; delayed starting which regulates acceleration to minimize belt strain; automatic takeups; and vulcanized splices. The values appearing under "Condition B" apply to belts which do not incorporate these modern design refinements.

Only a single value is given for the special fabric belts since they should be installed only on conveyors embodying all the design refinements listed above. A special-fabric belt involves a large capital investment, and it is economically unsound to endanger the life of a special fabric belt by not using all the conveyor design features available.

Operational Suitability

We must consider also the conditions under which the belt will operate before we can select the proper carcass construction. Certain fabrics will resist damaging effects such as impact, stretch and moisture better than will others. For example, both cotton and nylon fabrics are found superior to rayon in moisture-resistance. Where extreme moisture is present, the rayon construction ordinarily should be excluded from consideration.

Minimum and Maximum Number of Plies

The number of plies required to support a given load varies between fabrics. Similarly, the maximum number of plies of different fabrics vary as to crosswise flexibility or "troughability." These factors must be considered side-by-side. Tables 12 and 13 giving details and relationships are examples of information that must be obtained from the manufacturer.

Pulley Diameters

In addition to troughability, another factor to be considered in avoiding selection of a belt that is too thick, is the diameter of the pulleys. If the conveyor is new and pulleys have not yet been obtained, this consideration is important since a thinner belt allows use of smaller, less expensive pulleys. If the belt is for replacement service, or for a new conveyor whose pulleys have already been obtained, the carcass must not exceed the permissible number of plies unless premature wear and damage is to be risked. To illustrate, Table 14 lists permissible belt (duck) thickness for various pulley diameters. This information is available for other types of belts.

If the belt is operating between 50 and 75% of maximum permissible tension, Pulley diameters in Table 14 may be reduced 20%. They may be reduced 30% if belt is operating at less than 50% of maximum permissible tension.

Table 11: Maximum Permissible Working Tensions

Belting fabric	Permissible tension (lb per in. per ply) Condition A	Condition B
Cotton duck		
28-oz	28	25
32-oz	33	30
36-oz	39	35
42-oz	50	45
48-oz	65	60
Rayon		
Style ER	45	40
Style XR	60	50
Style YR	75	60
Cotton-Nylon		
Style TN	35	30
Sytle EN	45	40
Style XN	60	50
Style YN	75	60
Ustex-Nylon		
Style XC	90	—
Style CX	110	—
Style CL	150	—
Super	200	—

Table 12: Minimum Plies to Support Load

Belt width (in.)	Crushed and sized ores weighing 75 pcf and less lump size to 3 in. DUCK (ounces) 28	32	36	42	48	Lump ores over 3 in. weighing 100 pcf and less 28	32	36	42	48	Heavy, coarse, abrasive weighing over 100 pcf 32	36	42	48
12														
18	4	4	3			4	4	4						
24	4	4	4	3		4	4	4	4		5	5	4	
30	5	5	4	4	4	5	5	5	4		6	6	5	5
36	6	5	5	5	4	6	6	5	5	4	7	6	6	5
42	7	6	5	5	5		7	6	6	5	8	7	6	6
48		6	6	5	5			7	6	6		8	7	7
54			7	6	6			8	7	7		9	8	8
60			7	7	7			8	7	7			8	8

SPECIAL FABRICS

Belt wdth (in.)	Styles XN	Styles YN	Ustex Nylon XC	Ustex Nylon CX	Ustex Nylon CL	Styles XN	Styles YN	Ustex Nylon XC	Ustex Nylon CX	Ustex Nylon CL	Styles XN	Styles YN	Ustex Nylon XC	Ustex Nylon CX	Ustex Nylon CL
24	4	4	5	4	4	5	4	5	5	4	5	5	6	5	4
30	5	4	5	5	4	5	5	6	6	5	6	5	7	6	5
36	6	5	6	6	4	6	6	7	6	5	7	6	8	7	6
42	6	6	7	6	5	7	6	8	7	6	8	7	8	8	7
48	7	6	7	7	6	8	7	8	8	7	8	8	9	8	8
54	7	7	8	7	6	8	8	9	8	8	9	8		8	9
60	8	7		8	7	9	8			8		9			9

Table 13: Maximum Plies For Proper Troughing

Belt width (in.)	Duck weights (ounces) 28	32	36	42	48	Special belting fabrics Styles XN	YN	Ustex Nylon XC	CX	CL
12	4	4								
18	6	5	4							
24	7	6	5	4		7	6	8	7	5
30	8	8	7	6	5	8	7	9	8	7
36	9	9	8	7	6	9	8	10	9	8
42	10	9	9	8	7	10	10	11	10	9
48		10	10	9	8	12	11	12	11	10
54			12	11	10	13	12	13	12	12
60				13	12	14	13		14	13

Table 14: Recommended Minimum Pulley Diameter (Ducks)

No. of plies	Tamden drive	Single drive, head & tripper	Tail. take-up, high tension snub	Low tension snub and bend
		28 oz and 32 oz		
3	18	16	12	12
4	24	20	18	18
5	30	24	20	20
6	36	30	24	20
7	42	36	30	24
8	48	42	36	24
9	54	48	42	30
10	60	54	42	30
		36 oz		
3	30	24	20	18
4	30	24	20	18
5	36	30	24	20
6	42	36	30	24
7	48	42	36	24
8	54	48	42	30
9	60	54	42	30
10	66	60	48	36
		42 oz and 48 oz		
3	—	30	24	20
4	36	30	24	20
5	42	36	30	24
6	48	42	36	24
7	54	48	42	30
8	60	54	42	30
9	66	60	48	36
10	72	66	54	42

Carcass Determination Procedure

A chart such as that shown above will organize all the information you'll need for determining the belt carcass. This chart will prove especially useful to you if your experience with belt selection problems is limited. And even the experienced belt-man will find that the chart simplifies his task, his know-how enabling him to take short-cuts in the following procedure:

Step 1. Draw up a blank layout for a chart like that shown. Now fill in the column headings.

Step 2. In the first column, insert the types of belt fabrics practical for your installation. The practicality of a fabric is determined by factors such as operational suitability. The most important guide in deciding which fabrics should be considered, however, will be your own experience with belting.

Step 3. In the second column write in the maximum permissible tension of each fabric, given in Table 11.

Step 4. In the third column write in the total tension per inch of belt width:

$$T_1/\text{in. belt width} = \frac{T_1}{\text{belt width in inches}}$$

CARCASS DETERMINATION CHART

1	2	3	4	5	6	
BELT FABRIC	MAX PERM WORKING TENSION (TABLE 13)	T_1/IN.	NO OF PLIES COL 3÷COL 2	MIN PLIES	MAX PLIES	REMARKS
42 OZ	50	617	12.3 OR 13	5	5	WON'T TROUGH PROPERLY
48 OZ	65	617	9.5 OR 10	4	4	"
EN	45	617	13.7 OR 14	6	8	"
XN	60	617	10.3 OR 11	5	7	"
YN	75	617	8.2 OR 9	4	6	"
XC	90	617	6.8 OR 7	6	8	TOO MANY PLIES
CX	110	617	5.6 OR 6	5	7	SUITABLE CONSTRUCTION
CL	150	617	4.1 OR 5	4	7	"
SUPER USTEX-NYLON	200	617	3.1 OR 4	4	6	TOO EXPENSIVE

Step 5. Next find the required number of plies for each fabric by dividing the total tension per inch of belt width by the maximum permissible working tension:

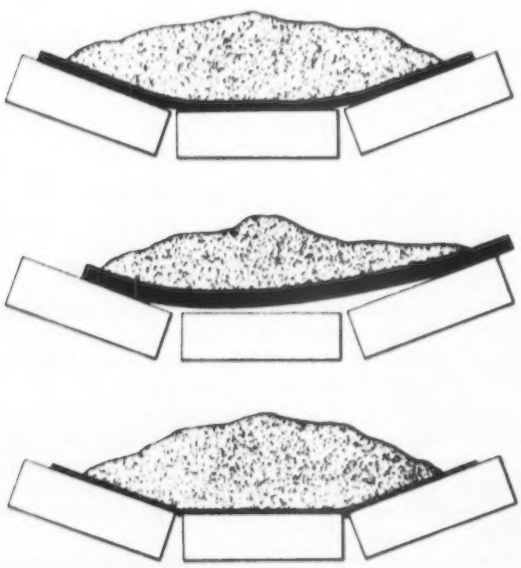
$$\text{No. of plies} = \frac{T_1/\text{in. belt width}}{\text{max. working tension}}$$

Round off each answer to the next larger whole number and enter it in its proper place in the fourth column.

Step 6. Refer to Tables 12 and 13 and enter in the fifth and sixth columns the permissible minimum and maximum number of plies for each fabric.

Step 7. Now eliminate from the chart the constructions which are unsuitable, as based on Step 6.

Step 8. Next, check each remaining construction against the minimum recommended pulley diameters given in Table 14. This will further narrow the number of suitable constructions, as explained on page 94.



BELT TROUGHABILITY. Belt at top has correct number of plies for proper troughing. Load is symmetrical and belt rides evenly on both side rollers. Belt in center is too thick; does not bend sufficiently to contact all idlers. Lower belt is too thin. Load forces belt into space between idlers where it is pinched.

Step 9. If more than one suitable construction remains after completing Step 8, it is generally wise to select the stronger fabric and lesser number of plies. This choice is preferred since it will trough better, will require smaller pulleys, and will usually be lower in price. In cases where alternative constructions make final selection difficult, consult your conveyor belt sales representative. He will be glad to assist you and explain cost considerations.

Applying Procedure

Let's determine the carcass for the belt for the ascending conveyor we analyzed in Part 1. The total belt tension is you'll recall, 18,520 pounds, and belt width is 30 inches. The material being handled is 125-pcf primary crushed iron ore. The drive is located at the head pulley and snubbed. The tail pulley serves also for takeup. Diameters are:

head pulley: 42 in.
snub pulley: 36 in.
tail pulley: 36 in.

Step 1. Draw up a chart as shown, filling in the column headings.

Step 2. Let's assume that the ore our conveyor is handling is very wet and that the surroundings are extremely damp. Now, keeping in mind these operating conditions and the high total tension to which our belt will be subjected, we are ready to insert in the chart all fabrics which can possibly result in practical constructions. As shown in the chart, we do not list rayon fabrics (Styles ER, XR, and YR), because they are unsuited to the wet ore and damp surroundings. And only the heaviest of the cotton ducks (42-oz and 48-oz) can give carcasses which will withstand the high total tension developed. Therefore, our chart lists the following fabrics: 42-oz and 48-oz cotton ducks; cotton-nylon Styles EN, XN, and YN; Ustex-Nylon Styles XC, CX, CL; and Super Ustex-Nylon.

Step 3. Refer to Table 11 and enter in the second column the maximum permissible working tension of each fabric. We'll assume our conveyor incorporates all design refinements, so we will use the values under *Condition A* of Table 11.

Step 4. In the third column note the total tension per inch of belt width:

$$T_1/\text{in. belt width} = \frac{T_1}{\text{belt width in inches}} =$$

$$\frac{18{,}520 \text{ lb (from page 44)}}{30} = 617 \text{ lb}$$

Step 5. To find the number of plies of each fabric required to withstand the total tension, divide the total tension per inch of belt width (third column) by the maximum permissible working tension (second column):

$$\text{No. of plies} = \frac{T_1/\text{in. belt width}}{\text{max. working tension}}$$

Round off each answer to the next larger whole number and enter it in the fourth column, as shown above.

Step 6. Refer to Tables 12 and 13, and enter in the fifth and sixth columns the permissible minimum and maximum number of plies for each fabric.

Step 7. Now eliminate from the chart the constructions which are unsuitable, as based on Step 6. As shown by the chart, 42-oz and 48-oz ducks, and Styles EN, XN, and YN are all eliminated because they require too many plies to trough properly. Since use of Style XC would require one ply more than use of Style CX, and two more than use of Style CL, we also discard this construction.

Step 8. Our possible constructions are now reduced to six plies of Style CX, five plies of Style CL and four plies of Super Ustex-Nylon. The next step in selecting the

Your Check Chart for Getting More Out of Your Conveyor

Storage and handling

- ☐ Store belts in an upright position.
- ☐ Store belts in a cool dark place.
- ☐ In underground storage, coat belt edges with rubber cement. (Excludes moisture from plies if edges are worn or cover edge cracked.)
- ☐ Don't use steel bars to pry or move uncrated rolls.
- ☐ Be sure to roll crated and rolled belts in the direction indicated; i.e., same way roll is wound.
- ☐ Don't drop belts or crates.
- ☐ Don't flex belt to bends sharper than minimum pulley diameter.

Installation

- ☐ Inspect component parts thoroughly before installation:
  - ☐ Structure.
  - ☐ Pulleys.
  - ☐ Idlers.
  - ☐ Loading devices.
  - ☐ Other alignment equipment.
- ☐ Ensure alignment of head and tail pulleys, idlers, and structure.
- ☐ Lay belt out properly.
- ☐ Mount belt squarely on rod passed through center of core.
- ☐ Pull belt into position by block and tackle, winch, or similar equipment.
- ☐ Unwind belt by power equipment—from top of roll if belt is led onto troughing rollers, or from the bottom if led onto return idlers.
- ☐ As belt is unrolled on to pulleys and idlers, it must be kept taut to prevent excessive unrolling or telescoping. Sharp twists, bends and excessively hard pulling should be avoided to prevent high strain and tension on the belt.
- ☐ Unwind slowly. Be careful that the belt doesn't catch and that no kinks occur.
- ☐ Exert sufficient tension to tighten until the sag is taken out between return idlers with belt takeups in correct position.

Train belt properly

- ☐ Check return belt.
- ☐ Check tail pulley.
- ☐ Check for deflection.
- ☐ Take necessary measures to ensure trained belt.

Loading chutes and discharge devices

- ☐ Check for alignment.
- ☐ Ensure that belt does not rub against equipment.

Skirtboards

- ☐ Check for alignment.
- ☐ Belts must not contact metal or wood skirtboards. If contact with belt is necessary, use rubber skirts. *Do not use old belting for skirts.*

Operation

- ☐ Use controlled starting as opposed to across-the-line starting. Avoid abrupt stops.
- ☐ Loading:
  - ☐ Uniform rate of speed.
  - ☐ Symmetrical load distribution.
  - ☐ Acceleration of material in belt movement direction.
  - ☐ Minimum angle between stream of material and belt.
  - ☐ Minimum drop of material.
  - ☐ Load fines first when possible.
  - ☐ Skirtboards. Dual skirting is recommended where possible.
  - ☐ Load at horizontal section of belt.

Control discharging of material

- ☐ Control trajectory of discharge.
- ☐ Trippers and plows.

Maintenance

- ☐ Periodic inspections of entire conveyor system.
- ☐ Alignment.
- ☐ Inspect for sharp edges, etc.
- ☐ Edge wear.
- ☐ Ensure proper lubrication.

Keep belt surfaces clean

- ☐ Belt scrapers.
- ☐ Belt brushes.

carcass is a check of all possible constructions for suitability to pulley diameters. Our conveyor has a single-pulley snubbed drive, with the head pulley serving as the drive pulley, and the tail pulley serving as the takeup pulley. The head pulley diameter is 42 in., and the snub and tail pulley diameters are 36 in. Checking with Table 14, we find that all the possible constructions meet minimum pulley diameter requirements.

Step 9. The final selection must therefore be made on the basis of economics. Although ordinarily the carcass using the lesser number of plies of the stronger fabric is the cheaper (and therefore would be one we'd select), in our case the six-ply CX belt would cost less than the five-ply CL and the four-ply Super Ustex-Nylon belts. When belt selection procedures result in alternative constructions which must be based on price considerations for final choice, check prices on each construction.

Conveyor Belt Cover and Grade Selection

Extreme care should be taken in selecting the proper cover for a belt. The life of a belt, representing approximately 40% to 60% of the initial capital investment for your belt conveyor, depends upon the ability of its rubber cover to withstand wear and any destructive effects of the material conveyed. Experience proves that cover selection

must be based on the character of the material handled and its type and condition; the size and sharpness of the lumps; and the operating conditions.

Tables showing recommendations for different services can be obtained from the manufacturers of belt. Such tables however, do not take the place of practical judgment based on experience. A study of belting to be replaced may best indicate the changes required in the design of a replacement belt. For example, if the cover is worn through, a thicker, or better grade should be selected; if gouged or torn, a breaker strip should be included and cover grade and thickness should be checked.

Back Cover Thickness

Thickness of the back of pulley-side cover depends mainly on the probability of damage from material getting between the belt and the pulleys. Haulage of abrasive materials usually requires a thicker cover than haulage of non-abrasive. Also, greater belt tensions require thicker belt covers. In general, back cover thickness should be $\frac{1}{16}$-in. For unusually severe operating conditions, a back cover thickness greater than $\frac{1}{16}$-in. is advisable.

Required Belt Length

The following factors must be taken into consideration in ordering the correct length of belt required for your specific installation:

1. Twice the c-c distance.
2. Length needed to make the splice, if vulcanized splice.
3. Enough belt to accommodate drive, terminal, snub, bend, tripper, and takeup pulleys.
4. Additional belt to meet contingencies as follows:

Belt length (sum of 1, 2, and 3 above)	*Percentage of belt length to add*
Under 2,000 ft	1.0
2,000 to 5,000 ft	0.5
Over 5,000 ft	0.25

How to Get Longer Belt Life

Getting your money's worth out of your belt investment doesn't end with selecting the best belt for the job. This is a good start, but belts must be properly installed, maintained and inspected for maximum service. Here are a few cases where careful belt selection, dollars, time and labor were wasted because of negligence:

1. A belt carrying hematite from the primary crusher was spliced out-of-square and ran crooked causing excessive edge wear. The abrasive dust created by the primary crusher penetrated the belt's worn edges and separated the plies. Careful splicing and test cycling during installation would have prevented this damage and saved a considerable amount of money.

2. A belt-line was used to carry ore in a narrow, low-headroom panel of a lead-zinc mine. The crowded conditions that ruled out selection of other types of haulage also made inspection and service of the belt-line difficult. As a result, maintenance personnel tended to neglect periodic inspections. In one instance, decking which had been removed to make repairs was not replaced. Since inspection was irregular, the oversight was not caught. Spillage from the carrying side of the belt was no longer deflected and, consequently, built up around the return idlers, seizing them. The belt abraded the seized idlers, wearing sharp edges on the idler shells which inevitably cut the belt. This costly damage could have been prevented by a systematic, thorough inspection.

3. During installation a belt on a traveling stacker used to stockpile sized ore was accidentally torn by a steel bar used to move the belt roll. The damage was so slight that no effort was made to repair the small tear. After several months of operation, the tear widened, and moisture began to seep in, destroying the bond between the plies. Result—serious belt injury which could have been prevented by proper handling and prompt repair.

All of these costly accidents could have been avoided by proper belt care as outlined in the check chart on p 99.

Why Keep Service Records

Accurate records are the backbone of every sound business venture. This is particularly true of *Belt Service Records.*

Efficient belt-line operators keep these records to provide an accurate picture of a belt conveyor's performance. And these records offer a simple method of making exact cost-per-ton analyses that may mean the difference between future profits and loss—the difference between a belt-man's doing a good job or a poor one. The true cost of a conveyor or elevator belt can't be determined accurately until it is ready for replacement and all factors can be evaluated. You may then find that a high-priced belt giving long service is far more economical than an inexpensive belt having a short life.

Know your belt. Service records place all the operating factors that affect belt performance at a belt-man's fingertips. They enable him to predict the tonnage he'll get out of a belt, help him head off trouble and work out an effective inspection-maintenance schedule.

Belt selection is more accurate. Service records are a major aid in proper belt selection. They indicate any changes that may be needed in a replacement belt. Although belt specifications can be developed independently of performance records, experience factors are always an invaluable aid in choosing the perfect belt for a specific job.

Reducing down-time. Service records help reduce down-time and maintenance costs by pointing out the causes of recurrent breakdowns. Furthermore, the operating data you record *now* will pay impressive dividends in the *future* when increased production necessitates conveyor alterations or additions . . . dividends in greater efficiency and trouble-free flow.

Improving our product. Finally, your service records give the belt manufacturer the vital information he needs to develop belting that will serve you better

How to Prevent Conveyor Accidents

Haulage accidents were responsible for the death of 80 mine workers in 1953 and were listed as the second most common cause of mine fatalities. Thirty per cent of these accidents were caused by inadequate clearances and 28% were attributed to the operation of haulage equipment. The regrettable fact concerning these accidents is that they continue to occur despite the ease with which they can be avoided. The National Safety Council has stated that the increased use of belt conveyor systems can eliminate this type of accident.

However, even the replacement of other haulage means by belting cannot guarantee accident-free operation. Certain fundamental precautions must be taken. An accident prevention check sheet in the hands of a belt-man can be the proverbial stitch-in-time. Following the *Accident Prevention Check Sheet* below is a good first step toward 100% safety.

Follow These Steps in Selection of the Proper Belt for Your Job—Keep Parts I and II in Your File for Future Study

Step 1. Calculate total belt horsepower (Part I)

a. Horizontal conveyors

(1) level hp = "C" factor x tph x L_a

(2) tripper hp = for belt- or self-propelled trippers—"A" factor x fpm + $\frac{\text{tph x tripper lift (ft)}}{990}$ for all other trippers— $\frac{\text{tph x tripper lift (ft)}}{990}$

(3) Total belt hp = level hp + tripper hp

b. Ascending conveyors (page 00)

(1) level hp = same as for horizontal

(2) vert hp = $\frac{\text{tph xH}}{990}$

(3) total belt hp = level hp + vert hp

c. Descending conveyors

(1) level hp = same as for horizontal conveyors

(2) vert hp = $\frac{\text{tph x (—H)}}{990}$

(3) empty belt hp = $\frac{\text{percentage of level hp at 100\% loading x level hp}}{\text{per cent loading}}$

(4) total belt hp = larger of

1. empty belt hp
   and
2. * level hp + (—vert hp)
   or
   ° ½ level hp + (—vert hp)

Step 2. Calculate motor hp

motor hp = $\frac{\text{total belt hp}}{\text{drive efficiency}}$

Step 3. Calculate total belt tension

a. Horizontal conveyors

total belt tension = $\frac{\text{hp x 33,000}}{\text{fpm}}(1 + K)$

b. Ascending conveyors

total belt tension = larger of

1. $\frac{\text{total belt hp x 33,000}}{\text{fpm}}(1 + K)$
2. $\frac{\text{total belt hp x 33,000}}{\text{fpm}} + (WH - F_R)$

c. Descending conveyors

total belt tension = larger of

$\frac{\text{total belt hp x 33,000}}{\text{fpm}}(1 + K)$

or

$\frac{\text{total belt hp x 33,000}}{\text{fpm}} + (WH + F_R)$

Step 4. Determine the carcass (page 94)

a. Total tension/in. of belt width = $\frac{\text{total belt tension}}{\text{belt width}}$

b. Number of plies = $\frac{\text{total tension/in. of belt width}}{\text{max working tension}}$

Step 5. Select cover thicknesses

Step 6. Select belt grade

Accident Prevention Check Sheet

General precautions

- ☐ Provide for adequate clearance to ensure safe maintenance.
- ☐ Prohibit riding of belts by personnel.
- ☐ Use non-inflammable non-poisonous cleaning fluids in splicing operations.
- ☐ Provide crossovers at sufficient intervals to eliminate the temptation to climb over moving belts.
- ☐ Provide a railing along belt walkway.
- ☐ Make sure personnel are clear of belt before starting it.

Electrical-origin fire prevention

- ☐ Regular inspection of drives and other electrical apparatus.
- ☐ Install automatic overload switches. Check regularly.
- ☐ Install heat-sensitive switches. Check regularly.

Drive pulley slippage fire prevention

- ☐ Install centrifugal switches. Check regularly.
- ☐ Install automatic takeups. Check regularly.
- ☐ Install emergency wire-pull and roof-fall cutout switches. Check regularly.
- ☐ Install chute pileup paddle switch. Check regularly.
- ☐ Use rubber drive pulley lagging or grooved lagging. Check regularly.

Belt wear friction fire prevention

- ☐ Ensure proper training.
- ☐ Check skirtboards for proper clearance.
- ☐ Check loading chutes and devices for proper clearance.

Good housekeeping

- ☐ Keep lubricants and other inflammables in fire-proof cabinets.
- ☐ Don't leave oil waste and debris lying around.
- ☐ Install adequate dust control systems.

* For comparison if vert hp *numerically smaller* than level hp
° For comparison if vert hp numerically larger than level hp

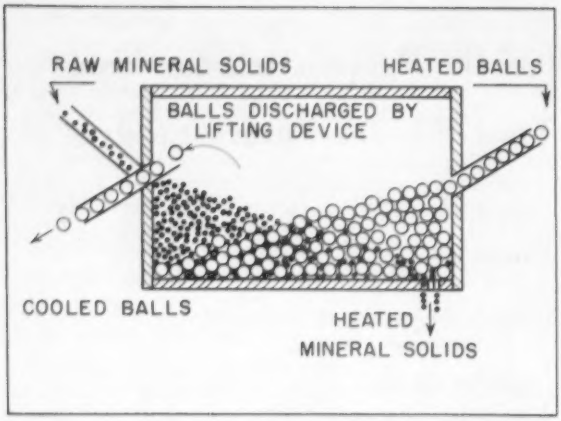


FIG. 1. Feeding hot balls and cold ore counter-currently drives off the oil, discharges cold balls and hot oil-bearing shale.

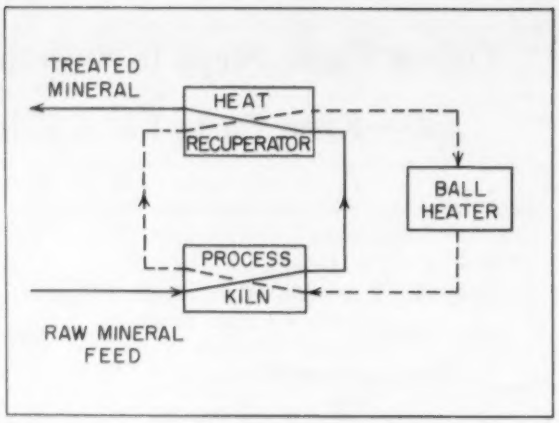


FIG. 2. Feeding cold balls and hot ore counter-currently permits recovery of some of the heat contained in the treated shale.

Solid-Solid Contacting— The Aspeco Oil Shale Process

DAVID W. MITCHELL

MOST RECENT DEVELOPMENT is the use of solid-to-solid contacting and heat transfer is the Aspeco Process, currently being piloted at Denver Research Institute, while a one-ton-per-hour pilot plant is being erected by Stearns Roger Mfg. Co. nearby. Process fundamentals have been proven in DRI's 300-lb per hour plant, and a large oil-shale processing plant may be designed on the basis of the upcoming one-ton per hour trial.

Heat transfer plays an important role in many operations and processes utilized in the treatment of mineral crudes or concentrates, such as drying, calcining, roasting, smelting, cooling or quenching, and distillation. In most of these operations, heat transfer is accomplished by means of contact between mineral material and a gas phase, usually a product of combustion or containing products of combustion.

Rate at which heat is transferred between gas and solid phases is controlled by the resistance to transfer in the solid-gas boundary layer and the relative velocity of the gas.

Presence of fines very seriously limits the allowable velocity of the gas relative to the solid, because the moving gas stream transports fine solids and causes dust handling problems. In addition, fine particles of dust or fume may reduce the heat-transfer rate from gas to solid from the rate that would prevail in the absence of dust or fume.

In comparison with heat transfer between a gas phase and a solid phase, the transfer of heat from one solid phase to another offers a number of advantages among which are: high rate of heat transfer; absence of rapidly moving gas stream and consequent dust problems; ability to utilize heat obtained in one atmosphere, say an oxidizing one, in another atmosphere, say a reducing one; ability to move large amounts of heat contained in small volumes, appreciable distances as sensible heat in solid bodies.

How the Process Works

In the Aspeco process, heat exchange between heated, metallic or ceramic balls and crushed mineral crude is accomplished in a rotary kiln or drum, the balls and mineral travel countercurrently to each other. In Fig. 1, the Aspeco heat-transfer process is illustrated.

Here the initially cold mineral solids move counter-currently to the initially hot heat-carrying balls. The balls discharge relatively cold and the mineral solids relatively hot. Heat in the mineral solids may be recovered in a similar operation feeding the relatively cold balls counter-currently to the hot solids.

Fig. 2 shows continuous processing operation for treating a mineral crude. Heat is supplied to the processing kiln. Some of the sensible heat in the treated mineral is recovered in the heat-recuperator kiln. Treated mineral solids are discharged at a low temperature and needed process heat is supplied to the balls in the ball-heating unit.

At first thought it may seem unlikely that the ball stream and the crushed-mineral stream could move in opposite directions, but consideration of the driving forces causing motion and the mode of passage of one kind of solid through the other makes the idea more reasonable. Balls move from the ball-feed end to the ball-discharge end of the kiln, because the potential energy of a ball at the feed end is greater than at the discharge end. In other words, the balls roll downhill. The same thing is true for the mineral solids. Rotation of the kiln loosens the solids sufficiently so that the frictional resistance between the solids is not too high to permit longitudinal motion of both the balls and the crushed oil-bearing shale.

A screening-type lifter or scoop at the ball-discharge end is used to separate the heat-carrying balls from the crushed mineral solids when the heat-exchanging operation is complete. The capacity of the kiln is determined largely by the speed of rotation of the kiln and the screening capacity of the separating device. It is apparent that the heat-carrying

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balls must be larger than the crushed mineral material. Reversal of this size relationship would result in a mixture of heat-carrying bodies discharging with mineral fines. Maximum capacity for heat transfer will be obtained when the ball surface area per unit weight of balls is as large as possible, that is when the balls are as small as possible.

Compare With Gas-Solid

Experiments to determine the rate at which heat could be transferred from solid steel balls to crushed mineral solids have been conducted by the author. Heat transfer coefficients of 86, 70 and 46 Btu per hr per ft^2 of ball surface area per deg F difference in temperature between the ball surface and the mineral material were iron ore, minus ⅜-in. crushed gravel, and minus ⅜-in. Colorado oil shale respectively.

It is interesting to compare these figures with some for gas-solid heat transfer. The coefficient of heat transfer between pebbles and air in a pebble heat exchanger is about 4.3 to 4.5 under very favorable conditions, and with hydrogen the coefficient may be as high as 22 Btu per hr per ft^2 per deg F.

It is also of interest to note the effect of particle size on heat transfer rate. For the same crushed gravel mentioned above, the heat transfer coefficient was reduced from 70 to 16 when the minus 6 mesh fraction was removed. In the Aspeco solid-to-solid heat-transfer process the presence of fines is actually beneficial instead of detrimental as is the case with gas-solid heat transfer.

The volume of solid required to carry a unit of heat is much smaller than the volume of gas required for the same purpose. For example, at room temperature one cc of a common variety of ceramic ball material would carry 0.6 cal of heat per deg C, but it would require more than 2,000 cc of air (or nitrogen or oxygen) to carry the same quantity of heat; and the volume of air required would increase rapidly with the temperature. Thus, the amount of heat that can be introduced into a heating or reaction space is comparatively great at low flow rates for solid-to-solid transfer systems.

A practical test of the Aspeco system is being conducted in Denver, Colorado by the Denver Research Institute for the Oil Shale Corp., Beverly Hills, Calif. A one-ton-per-hour Aspeco pilot plant for extracting oil from Colorado oil shale is being constructed by the Stearns-Roger Mfg. Co. and will be operated by the Denver Research Institute, starting in 1957. A small 300-lb per hr pre-pilot unit has already been operated for several months. Results to date demonstrate the mechanical, chemical and thermal soundness of the process. The pilot plant will be operated to obtain data for cost estimation and plant design for large-scale, oil-shale treatment.

Additional related projects contemplated for the oil-shale pilot plant include testing the process for use with tar sands, such as the Casmalia Sands of California and the Athabaska Sands of Canada.

Applicable to Iron Ore

An Aspeco process pilot plant for experimental work on magnetic roasting of hematitic taconites using hydrogen as the reducing agent has been designed and will probably be built soon by Linden and Co., Beverly Hills, California. In this application, pre-heated hydrogen gas is to be contacted with a bed of mixed balls and ore in an Aspeco kiln. The reduction of Fe_2O_3 to Fe_3O_4 with hydrogen is almost indifferent with respect to heat of reaction so that the heated balls will have only to heat the ore. Similar work on reduction of iron mineral to sponge iron with hydrogen is to be done. In this case, however, the balls will have to carry the heat of reaction as well as provide the sensible heat.

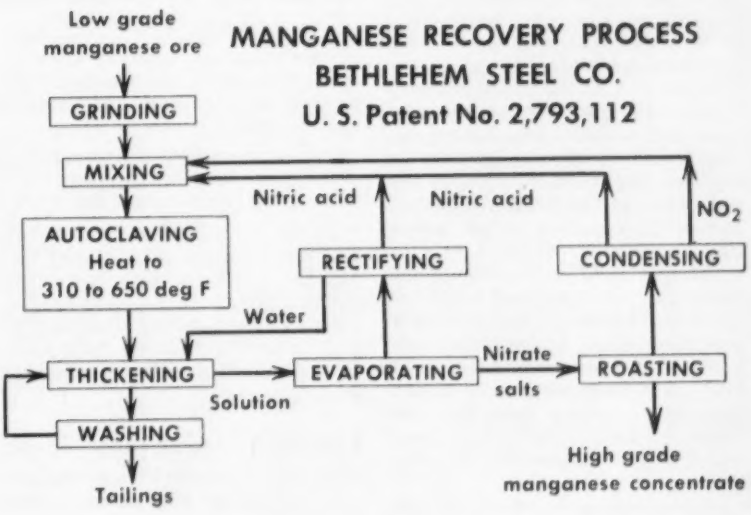
There appear, to be a number of other applications for the Aspeco solid-to-solid heat transfer process in the mineral field. Under consideration at the present time are applications for calcining gypsum and the distillation of mercury from ores.

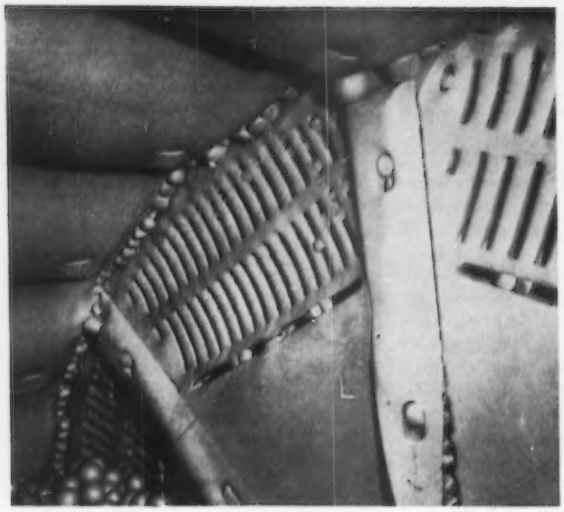
Bethlehem Patents Manganese Process

PROCESS FOR RECOVERING high-grade manganese concentrate from low-grade manganese ore has been developed and patented by E. B. Mancke, and assigned to Bethlehem Steel Corp.

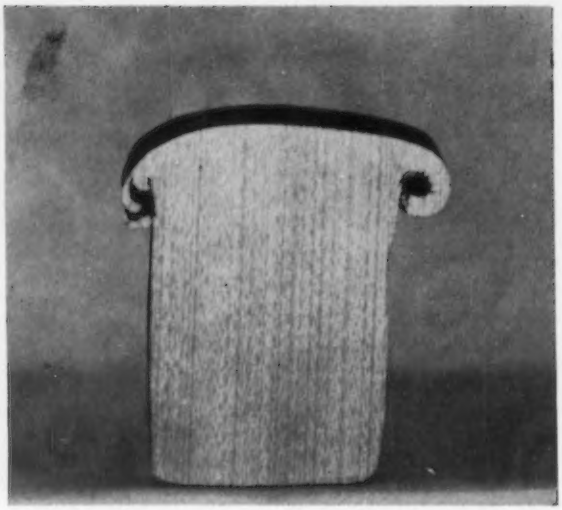
In the process, ore is ground, treated with fresh and recycled nitric acid and nitrogen dioxide, and then autoclaved at high temperatures (310 to 650 deg F). Manganese nitrate solution is decanted and the tailing sands washed. Liquor is evaporated and the nitrate salt residue is roasted to produce a manganese oxide concentrate.

Flowsheet shows the various steps of the process. High temperature autoclaving increases considerably the solution of manganese and removes from solution much of the iron and phosphorus. It will be noted that aqueous nitric acid recovered from both the evaporating and roasting steps is fed back into the system for leaching fresh ore. Although this process preferably is operated continuously, it can be adapted to batch methods if desired. This information is available in U. S. Patent No. 2,793,112.





PEENING ACTION on wearing face of chrome-moly grate bars prevents plugging by worn balls in grate ball mill.



DESIRABLE PEENING of corners at the wearing face of a worn Chrome-Moly grate bar is shown in cross section.

How to Select Chrome-Moly Steels For Ball and Rod Mill Liners

T. E. NORMAN

THE RECENT TREND to the use of large ball and rod mills emphasizes the need for careful selection of mill liner materials. Loss of production due to shutdowns for liner replacement is an important consideration in these large capacity units. Furthermore, cost of liner materials, and labor to install new liners have risen sharply. In order to hold shutdowns for liner replacements or repairs to a minimum and to provide maximum economy per ton of ore ground, the selection of the liner material best suited to each application is an important consideration at all milling operations.

"Chrome-Moly" steel liners, are now being used in many ball mills and rod mills. Substantial savings in mill liner costs and in shutdown time have been obtained from their combination of desirable properties, which include good wear resistance, toughness, consistent and uniform performance, freedom from flow in service, and availability.

This article covers the properties, fields of application and comparative wear resistance of these "Chrome-Moly" liner steels. These comprise a family or range of compositions whose combination of toughness and wear resistance can be varied, by adjustments in composition and heat treatment, to suit the needs of specific applications.

Mr. Norman is metallurgical engineer for Climax Molybdenum Co., Midland Savings Bldg., Denver 2, Colo.

Classification of Chrome-Moly Liner Steels

Two important types of Chrome-Moly liner steels, classified according to their microstructure and hardness are as follows:

Type	Brinell Hardness Range
(A). Pearlitic	250–450
(B). Martensitic	450–700

In the above classifications, carbon and alloy content of the steel and its heat treatment can be varied, within limits, to suit specific applications or liner designs and also to some extent to suit the production facilities and alloy preferences of various producers.

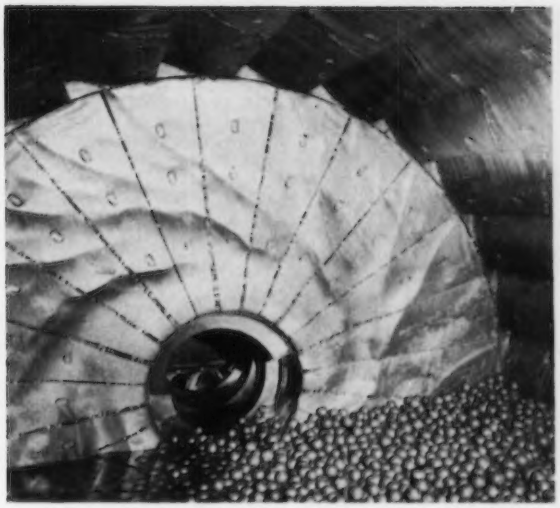
Pearlitic Chrome-Moly Steels

Applications and Physical Properties. This is the type of steel which has, in the past, been generally made by producers of Chrome-Moly liners. While it is not as hard or as wear resistant as the high carbon martensitic steels, it is usually easier and cheaper to produce and it has inherently better toughness along with sufficient wear resistance to provide definite savings in many types of liner service.

The fields of application for these pearlitic steels include liners for ball mills and rod mills operating under moderate to high impact conditions, low discharge grate assemblies for low discharge mills, and wedge or clamp bars used in some liner designs to hold liner plates in place. These steels are also being used successfully in liner plates having a combination of thin and thick sections, such as the "double wave" design.

One physical property which must be considered in many liner installations is the resistance of the metal to plastic flow under the action of balls or rods. This flow in turn may cause breakage of liner bolts or even buckling and serious warpage of the liners. Low yield strength materials such as austenitic manganese steel are susceptible to this plastic flow. The Chrome-Moly liner steels, on the other hand, have a relatively high yield strength (90,000 to 150,000 psi). This permits them to resist flow very successfully. This has been a governing factor in the choice of Chrome-Moly steels for certain mills, particularly those of the high impact type.

Pearlitic Chrome-Moly liner steels



SPIRAL WEAR pattern is clockwise even though rotation of mill at Climax is counterclockwise. Type 2 martensitic steel.

NOTE FAINT counterclockwise wear pattern in this mill with clockwise rotation. Type 2 chrome-moly martensitic steel.

are generally produced to various hardness ranges to meet varying conditions of service or liner design. Typical ranges are as follows:

Application	Brinell Hardness
Liner plates for severe impact	300–350
Liner plates for moderate or light impact	350–420
Wedge or clamp bars	300–350
Low discharge grates	250–300

These ranges may be modified somewhat to suit the liner design. For instance, long liner plates with three or more bolt holes, or liner plates with thin and thick sections should normally be on the low side of the above hardness ranges. Liner plates, which are short, which are of near uniform cross section, or which are held in place by wedge or clamp bars can safely be used near the top side of this hardness range. The higher side of the hardness range will, of course, normally give best wear resistance.

A special condition exists in the physical property requirements for low discharge grates. Here, slots in the grates will show much less tendency to plug up with worn balls or steel slugs if grate bars which form these slots are kept soft enough to allow a controlled amount of peening by action of the ball charge. This peening forms a constriction of the opening to each slot. Any steel slugs which are small enough to pass through this opening will then be too small to wedge between the grate bars. See photo of low discharge grate which has peened properly in service. Note freedom from plugging of the grate openings. Note adjacent section cut from a worn Chrome-Moly grate bar. Note how the ball action has peened the wearing edge of this bar to form a shoulder. This is a desirable condition, providing, of course, the peening is not excessive to the point that the flow of ground pulp through the grate openings is seriously restricted. In the case shown p 102, the grate openings were originally ¾ in. wide and these were narrowed down to about ½ in. at the entrance by the peening action. This was found to be about right for the mill in which these grates were used. Hardness of the grate bar shown was 255 brinell.

Methods of Manufacture. Pearlitic types of Chrome-Moly steel liners may be produced in either cast or wrought (rolled) form. When made as castings they can be designed in shapes and contours to suit needs of individual mills. Rolled liners must be of simple and standardized design and usually consist of plates of uniform thickness held in place by wedge or clamp bars. For "shell" or "barrel" liners both the cast and the rolled types are used. For end liners and discharge grates, shape considerations are such that liners are almost universally made as castings.

Chrome-Moly liner steels are usually melted in acid- or basic-lined electric or open hearth furnaces. Their adaptability to production in various melting units makes them widely available from many sources of supply.

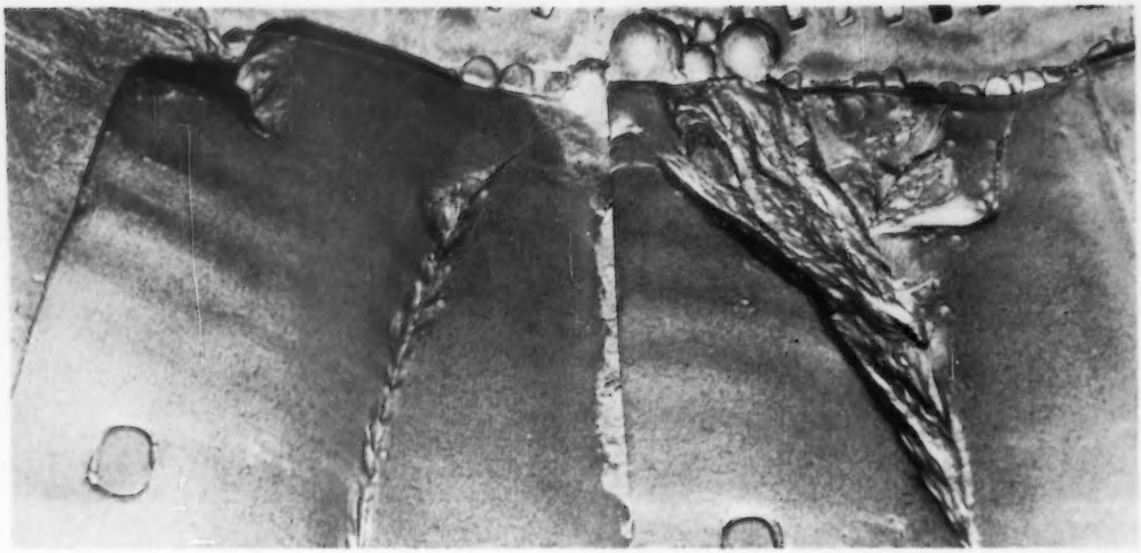
Chemical Composition. Pearlitic types of Chrome-Moly liner steels are essentially a high carbon steel containing sufficient chromium and molybdenum to produce a "hard pearlitic" structure after a suitable heat treatment. The use of additional alloying elements such as nickel or vanadium is optional and usually depends on the alloy preferences of individual producers. Typical composition ranges are as follows:

	(a)	(b)
Carbon	0.70–1.10	0.50–0.70
Manganese	0.60–0.90	0.60–0.90
Silicon	0.30–0.80	0.30–0.80
Chromium	1.50–3.00	1.00–2.50
Molybdenum	0.30–0.50	0.30–0.50
Nickel (optional)	0.00–1.50	0.00–1.50

Composition (a) above with its higher carbon content, is used largely where maximum wear resistance is the primary consideration. Composition (b) with its lower carbon and often a lower chromium content does not have as good wear resistance as (a) but it will normally have greater toughness. Composition (b) is, therefore, preferable for ball mill grates and for liners or clamp bars subject to severe impact.

Although the above ranges in chemical composition are wide, the range adopted by a producer of liners should be much narrower than those given above. Also where nickel is used in the composition, it should be combined with chromium contents which are on the lower side of the above ranges. The specific composition adopted by individual producers should depend, to some extent at least, on facilities for heat treatment and quality control.

Heat Treatment. While Chrome-Moly steel liners have been used with good success in their as-cast or as-rolled condition, it is desirable, from the standpoint of uniformity and con-



SPALLING AND CRACKING of shell liners was due to excessively brittle material in experimental liners. Liner life was relatively good but danger of premature failure due to spalling rules out this type of liner for high-impact grinding mills.

sistency of properties, to give these liners a heat treatment. Preferable treatment is as follows:

Heat to 1700-1800 deg F and soak at temperature about one hour per inch of section.

Cool in mildly moving air.

Temper at 800 to 1000 F for service requiring best wear resistance with moderate toughness.

or

Temper at 1100 to 1250 deg F for service requiring highest toughness (with some sacrifice in wear resistance).

Actual hardness attained in liners (or grates) after this heat treatment will depend, within limits, on their specific composition, section size, degree of air circulation during cooling and tempering temperature. We recommend that these variables be adjusted and balanced by each producer to develop the hardness best suited to specific applications, as given on page 103. Most producers of liners and grates now have had sufficient experience so that they can meet the desired hardness range without difficulty.

Microstructure. Extensive wear testing shows that two main factors controlling wear rates of steel liners (and grinding media), in ball and rod mills, are the carbon content and the microstructure. It has further been demonstrated by both small and large scale tests in our own ball mills at Climax, and in mills at other mining operations, that a high-carbon steel with a "hard pearlitic" structure will have outstanding wear resistance which is exceeded only by a harder (but usually less tough) high carbon martensitic structure. Chrome-Moly steel liner compositions and treatments described in this section are designed to develop this "hard pearlitic" structure. Fig. 3 shows a typical structure of this type, which was obtained from a 5-in. thick section of a ball mill liner.

Martensitic Chrome-Moly Steel

Steels with a martensitic structure, which normally range from about 450 to 700 brinell, have interesting possibilities for ball and rod mill liners. Such a structure, when it has a medium to high carbon content, is normally more wear resistant than a "hard pearlitic" structure and is much more wear resistant than austenitic manganese steel. However, the development of a sufficiently tough martensitic structure in large, heavy section liner castings involves certain production problems and higher production costs. Furthermore, there is the risk of breakage or spalling when these very hard martensitic structures exist in liners. In spite of these difficulties, the possible advantages from longer liner life are sufficient to justify serious consideration of a martensitic steel for many liner applications. These applications include end liners for ball mills and shell or barrel liners for mills operating under moderate to light impact.

Several liner producers are now making cast Chrome-Moly steel liners of the martensitic type and these have operated successfully in a number of large ball mills, where they were used both as end and as shell or barrel liners.

Chromium and molybdenum, sometimes in combination with other alloying elements, are used in these martensitic steel liners to obtain the necessary hardenability. The compositions and treatments used for these liners may be classified into three general types. See Table 1.

Type 1, with its relatively low carbon content, will show good toughness in spite of its high hardness. This type can be water quenched without cracking, hence it requires

Table 1. Three Types of Mill Liners

Composition[1] — per cent	Type 1	Type 2	Type 3
Carbon	0.30–0.40	0.60–0.80	0.80–1.20
Manganese	1.00–1.50	0.60–0.90	0.60–0.90
Silicon	0.30–0.80	0.40–0.80	0.40–0.80
Chromium	0.50–1.00	1.25–7.00	5.00–7.00
Molybdenum	0.40–0.60	0.40–0.60	0.70–1.00
Hardening treatment (Type of quench)	Water	Liquid or air	Air
Hardness-Brinell	450–550	550–650	600–700

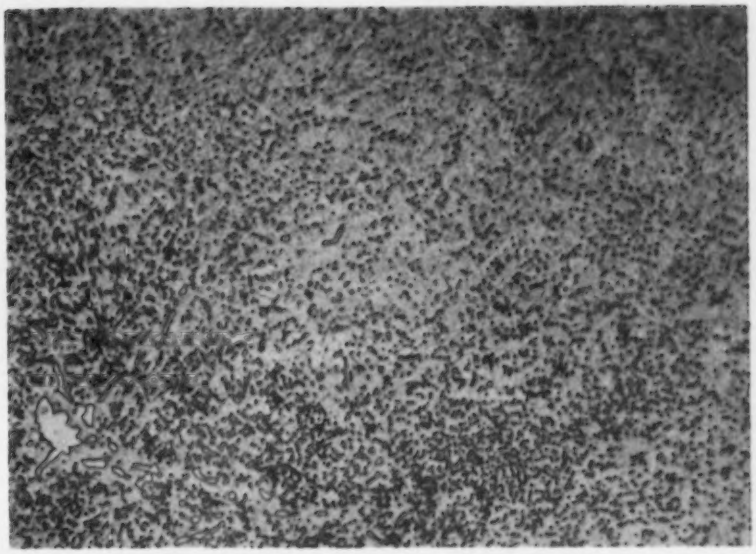
[1]Composition limits given above cover the entire range from several producers. The range in composition from an individual producer will normally be much narrower than those given above.

only a relatively low alloy content to produce full hardening. However, the low carbon content of Type 1 steel has an adverse effect on wear resistance, so that in spite of its high hardness it may not show any better life in liners than is obtainable from the softer but higher carbon grades of pearlitic Chrome-Moly steel. Service records on this low carbon type of martensitic steel are still quite limited, so an accurate prediction of its relative merits is not yet possible.

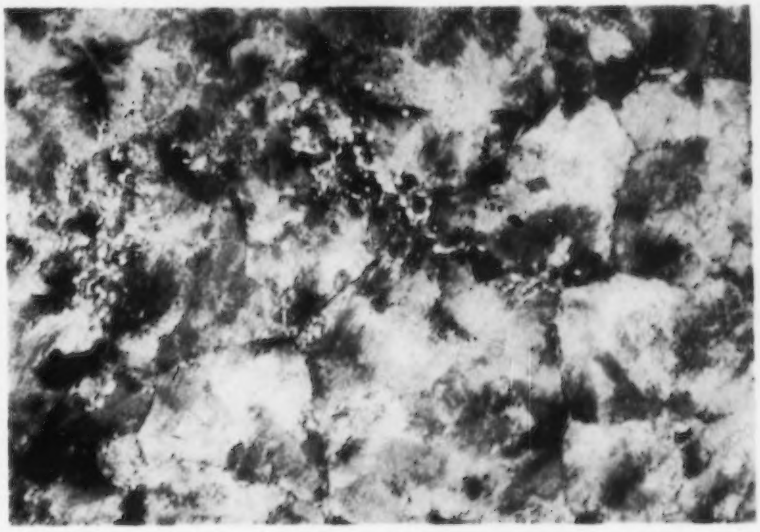
Type 2, with its combination of fairly high carbon content and high hardness, is potentially an excellent wearing material for liners. It is, of course, less tough than the Type 1 steel and to avoid quench cracking during hardening the liners made from this Type 2 alloy must be given a less drastic quench, such as an air quench or quench in a molten salt bath. A higher alloy content is required to produce full hardening under these conditions.

Many hundreds of tons of Type 2 martensitic steel have been cast and used in ball and rod mill liners recently. Use of this type of steel as a commercial liner material now appears to be well established. In our own mills at Climax, this type of steel shows about 20% longer life than pearlitic (type a) Chrome-Moly steel.

The Type 3 composition, when its carbon content is on the high side of the range, probably represents the near-optimum in commercially feasible wear resistant steels for ball or rod mill liners. This steel is still in its initial development stages, with only limited commercial usage to date as cast steel liners. However, the wear tests which we have run on this steel in our own ball mills at Climax have indicated that it does have outstanding wear resistance, together with good resistance to breakage or spalling, so it could well become an important liner material of the future.



MICROSTRUCTURE of high-carbon martensitic Chrome-Moly liner steel. Carbon spheroids dispersed in hard matrix. X1000.



MICROSTRUCTURE of high-carbon pearlite Chrome-Moly steel. Contains lamellar pearlite and undissolved carbide. X1000.

Selection of a Material for Mill Liners

The preceding sections of this article have discussed properties and fields of application for several types of Chrome-Moly steels. The selection of the best type for use in a specific application depends on many factors, such as first cost, design, availability, relative wear resistance, and relative toughness. Usually it is necessary to run service tests at each milling operation on several types of materials, including competitive liner alloys, before a choice of the most economical material can be defined. We can, however, offer some suggestions to serve as a guide in this selection and testing program.

How to Select Liner Steel

First, select a material which will not spall or break under the specific conditions of service in a given mill. Where impact conditions are severe, the use of the high carbon types of martensitic Chrome-Moly steels (and the martensitic white iron alloys) should be approached with caution. Under these circumstances, the three competitive materials normally chosen for comparative tests are: (1) Austenitic, Hadfield type, manganese steel, (2) One of the pearlitic Cr-Mo steels listed on page 106, (3) A rolled high carbon, unalloyed or low alloy steel, or (4) The medium carbon (type 1) martensitic steel listed on page 106.

Where impact conditions are moderate, or where very hard and relatively brittle materials, such as the martensitic white irons, will serve without breakage or spalling, consider the higher carbon types of martensitic Chrome-Moly steel listed as types 2 and 3 on page 106. These two higher carbon types of Chrome-Moly martensitic steel are inherently tougher than the martensitic white irons, so could readily serve in some applications where the martensitic irons have given trouble from breakage or spalling. *(Continued on next page)*

Table 2. Relative Wear Rates of Various Liner Materials When Tested as 5-in. Grinding Balls in a Ball Mill at Climax.

Item No.	Description	Composition—per cent					Hardness[1] (BHN)	Relative Wear Rate[2]	Order of Toughness[3]
		C	Mn	Cr	Mo	Ni			
1	Martensitic Cr-Mo white iron	2.8	1.0	15.0	3.0	—	740	89	6
2	Martensitic high Cr white iron	2.7	1.0	26.0	—	—	705	98	7
3	Martensitic high carbon Cr-Mo steel (Type 3)	1.0	0.8	6.0	1.0	—	615	100	5
4	Martensitic high carbon Cr-Mo steel (Type 2)	0.7	0.7	2.0	0.4	—	560	110	4
5	Martensitic Ni-Cr white iron	3.2	0.8	2.0	—	4.0	650	112	8
6	Martensitic medium carbon Cr-Mo steel (Type 1)	0.4	1.5	0.8	0.4	—	560	120	2
7	Pearlitic high carbon Cr-Mo steel (Type a)	0.8	0.8	2.5	0.4	—	380	127	3
8	Austenitic (Hadfield) manganese steel	1.2	12.0	—	—	—	470	138	1

[1]Hardnesses are converted from the average of Rockwell C readings on the worn surface of the balls. Hardnesses below this cold worked surface are normally lower than those given above.

[2]Relative wear rates are based on a nominally assigned factor of 100 for the high carbon martensitic steel (Item 3). Factors greater than 100 indicate faster rates of wear and factors of las than 100 indicate proportionately slower rates of wear.

[3]Order of toughness as listed here is a qualitative value. It is based partially on the results of laboratory physical tests and partially on the resistance to breakage and spalling which the respective materials have shown in actual service.

How to Run a Test

It normally requires many years to establish a reliable set of comparative data on relative wear resistance of various liner materials at a specific operation, when these data are based on actual sets of liners worn out in service. During such a long test period, operating conditions or liner designs may be changed so that the comparative value of such data then becomes questionable. To overcome this difficulty, we have devised a method of comparing liner materials in which the various materials are made into large (5-in. dia) marked balls and treated to produce the same structure and hardness in these balls as is normally obtained in liners of the same composition. These marked test balls are then run, all at one time, along with the regular ball charge in a large ball mill operating under normal grinding conditions for that mill. After a period of operation, these large test balls are removed from the mill and their relative wear rates are determined. Where comparisons are available, the results of tests on these liner materials in the form of large balls have correlated well with the results of comparative tests on actual liners made from the same materials. Table 2 gives the results from such a test in one of our primary grinding mills at Climax. This mill was a 9x9-ft grate-discharge type, grinding crushed molybdenum ore (in water) to a product suitable for subsequent treatment by flotation. The principal abrasive in this ore was quartz.

Relative wear rates given in Table 2 apply only to the grinding conditions which existed in the Climax primary ball mills. For other ball mills, we have reason to believe, from similar tests, that the order of merit of the eight materials listed will generally remain about the same but the spread in wear rates may be greater or less depending on the type of abrasive being ground and also to some extent on the operating conditions. Tests which we have run in a number of other mills indicate that a much wider spread may be expected in the grinding of iron ores, feldspar or cement materials, while smaller spreads may occur in grinding minerals harder than quartz.

Items 1 to 3 in Table 2 are experimental materials, at least in so far as their use in liners is concerned. Their relatively high alloy content and consequent higher cost must be balanced against their outstanding wear resistance. However, in certain mills, and particularly in those grinding minerals softer than quartz, our wear tests have indicated that a liner made from items 1 to 3 might last two or even three times as long as items 7 or 8.

Service Results

Chrome-Moly steel ball or rod mill liners are used regularly in at least fifteen of the major ore mills and at many smaller operations in U. S. They are also being used in many cement grinding mills. At most of these operations the basis for selection of the most economical liner material and design has been governed by many factors. While the good wear resistance of the Chrome-Moly steels has been an important factor in its selection, it cannot be considered as the only factor. Other important ones leading to this choice were favorable first cost, ready availability, freedom from premature failure by breakage or spalling, resistance to excessive flow in service, consistency of performance of life, and adaptability of the steel to use in the specific designs preferred by each milling operation.

Items 4 through 8 represent liner materials now in regular commercial use. While austenitic manganese steel (item 8) is at the bottom of the list in so far as wear resistance is concerned, it is still important commercially because of its high toughness. On the other hand, the martensitic Ni-Cr iron, as represented by item 5, is also used quite successfully in many mills, in spite of the fact that it has the lowest toughness of any of the materials listed in Table 1. It is obvious, therefore, that items 4, 6 and 7, which are the regularly available grades of Chrome-Moly steel, and which are intermediate in toughness between austenitic manganese steel and the Ni-Cr martensitic iron, should be usable in a wide range of liner applications. This has been demonstrated by the widespread use of these steels. They have found their greatest field of application to date as a replacement for austenitic manganese steel liners.

Liner Materials of the Future

The data in Table 2 provided a number of clues to what we may find in liner materials of the future. While item 1 stands at the top of this list in wear resistance, this must be balanced against its relatively high alloy cost and its limited toughness. Nevertheless, it may prove economical in mills which obtain a wide spread in relative wear rates.

The Chrome-Moly steel represented by item 3 also has most interesting possibilities. Its more moderate alloy cost, combined with its good wear resistance and better toughness, indicate that this alloy should be seriously considered as one of the more promising materials for ball and rod mill liners.

For high impact mills or for liner designs which require some ductility in the material, it will probably always be difficult to use any of the compositions represented by items 1 through 5. For such purposes, the two Chrome-Moly steels represented by items 6 and 7 still have much to offer and probably will continue to be used for many years to come.

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U.S. 4810 combines super adhesion and extreme flexibility. The rugged service that this hose provides throughout its long life proves that you are wasting dollars if cheaply constructed, short-lived air hose is being used instead of U. S. 4810 Air Hose.

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WHAT'S NEW IN U. S. PATENTS

OLIVER S. NORTH

Exploration

Device for determining the rate of deflection of a drill hole consisting of a semi-rigid, hollow tube carrying an axially disposed light source and an optical system. Means are provided for recording angular deviation of the light beam. Analyses of recordings shows the rate at which the hole is being deflected. H. O. Seigel and W. E. Bell, assigned to Newmont Mining Corp. No. 2,792,-637.

An improved electromagnetic device for determining the inclination and direction of deflected, inclined or horizontal drill holes. E. B. Roxström, assigned to Svenska Diamantbergborrnings Aktiebolaget, Stockholm, Sweden. No. 2,791,-035.

Mining

Clamping arrangement for channel-type metal profile or frame members used for supporting mine walls. Clamping members can be locked in fixed position relative to the ends of supporting members. Deformation of members under stress is lessened. W. Langerbein. No. 2,793,719.

Design for an efficient loading and hauling machine especially adapted for picking up from floors loose ores, for example potash ores of New Mexico. V. Perini. No. 2,793,775.

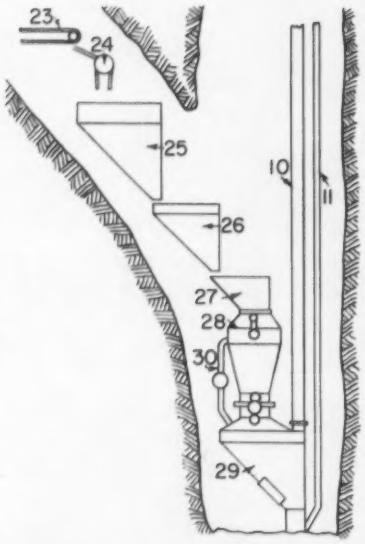
Ore Dressing

Improvements in method and apparatus for jig concentration of placer gravel. Pulsation is caused by vibration of an oscillating transverse wall pivotally mounted externally of the hutch. Advantages are reduction in height of concentrator and elimination of suction in the shot bed opposite the surge side, thus lessening compaction and stratification in the bed. F. C. Peterson. No. 2,793,750.

Improved cyclone method of separation of ores where a maximum grade of apex discharge is of prime importance, for example Minnesota iron ore. A truncated cyclone is used. E. C. Herkenhoff, assigned to Stamicarbon, N. V., Heerlen, Netherlands. No. 2,793,748.

In a new flotation cell construction, a vortex is established beneath the upper impeller by arranging the lower impeller to circulate pulp downwardly and outwardly instead of upwardly. In this apparatus, both impellers can be rotated at reduced velocities, with resulting decrease in wear of parts and lower power consumption. The efficiency of the cell is increased by prevention of banking, that is, accumulation of material in corners and on the bottom. J. F. Myers, assigned to Mining Process & Patent Co. No. 2,792,939.

Mr. North is patent consultant, Washington, D. C.



Hydraulic ore hoisting system consisting of two columns of water in vertical or sloping pipes connected at the bottom through a closed chamber to produce a static balance of water in both columns. Crushed ore is fed to the rising column of water through a series of locked chambers.

Drawing is a diagrammatic view of the lower or underground portion of the system. Supply column (11) transports liquid downward and hoisting column (10) moves the ore containing liquid upward. Ore is fed by conveyor (23) to grizzly or crusher (24) and ore bin (25). Measured amount of ore is held in loading bin (26) and dropped into guide hopper (27), which charges upper loading chamber (28) at the proper time. Pressure between upper loading chamber and lower loading chamber (29) is equalized through conduit (30), and then the ore is transferred to the lower chamber, where it mingles with the upwardly flowing column of water. Since chamber (29) is never open to the atmosphere, pressure therein is always the static pressure that exists in the columns at chamber level. It is essential that the liquid columns be maintained in static balance. Provision is made at the top of column (10) for recovering ore and recirculating water. P. S. Gardner Jr. No. 2,793,082.

Design for self-contained portable drill rig for use in exploratory or production drilling. L. A. Braun, assigned to E. J. Longyear Co. No. 2,792,198.

COPIES OF U. S. PATENTS can be purchased at 25c each from Commissioner of Patents, Washington 25, D.C.

Hydrometallurgy

Method for producing very pure, colorless soda ash from Wyoming trona. Ore is dissolved and crystals of sodium sesquicarbonate caused to be precipitated. Small portion of the mother liquor is treated with carbon dioxide to produce crystals of sodium bicarbonate, and the slurry of mother liquor and sodium bicarbonate crystals is then recombined with the main feed stream, which has been supplied with a mixture of raw crude and calcined crude trona. R. D. Pike (K. B. Ray and the Stamford Trust Co., as executors for said R. D. Pike, deceased). No. 2,792,282.

Method of separating mixed hydroxides of nickel and cobalt. Mixture is extracted with an aqueous chlorine-containing liquor to dissolve the trivalent nickel hydroxide, and then the liquid and solids separated. W. Voos, assigned to Lonza Electric & Chemical Works, Ltd., Basel, Switzerland. No. 2,793,936.

Cyclic process for recovering copper from copper ores, concentrates or similar materials with minimum expenditure of electrical energy. Ferric sulphate, the leaching reagent, is regenerated to ferrous sulphate at the anode with a current efficiency equal to that of the cathode copper deposition. S. B. Tuwiner, assigned to Phelps Dodge Corp. No. 2,792,342.

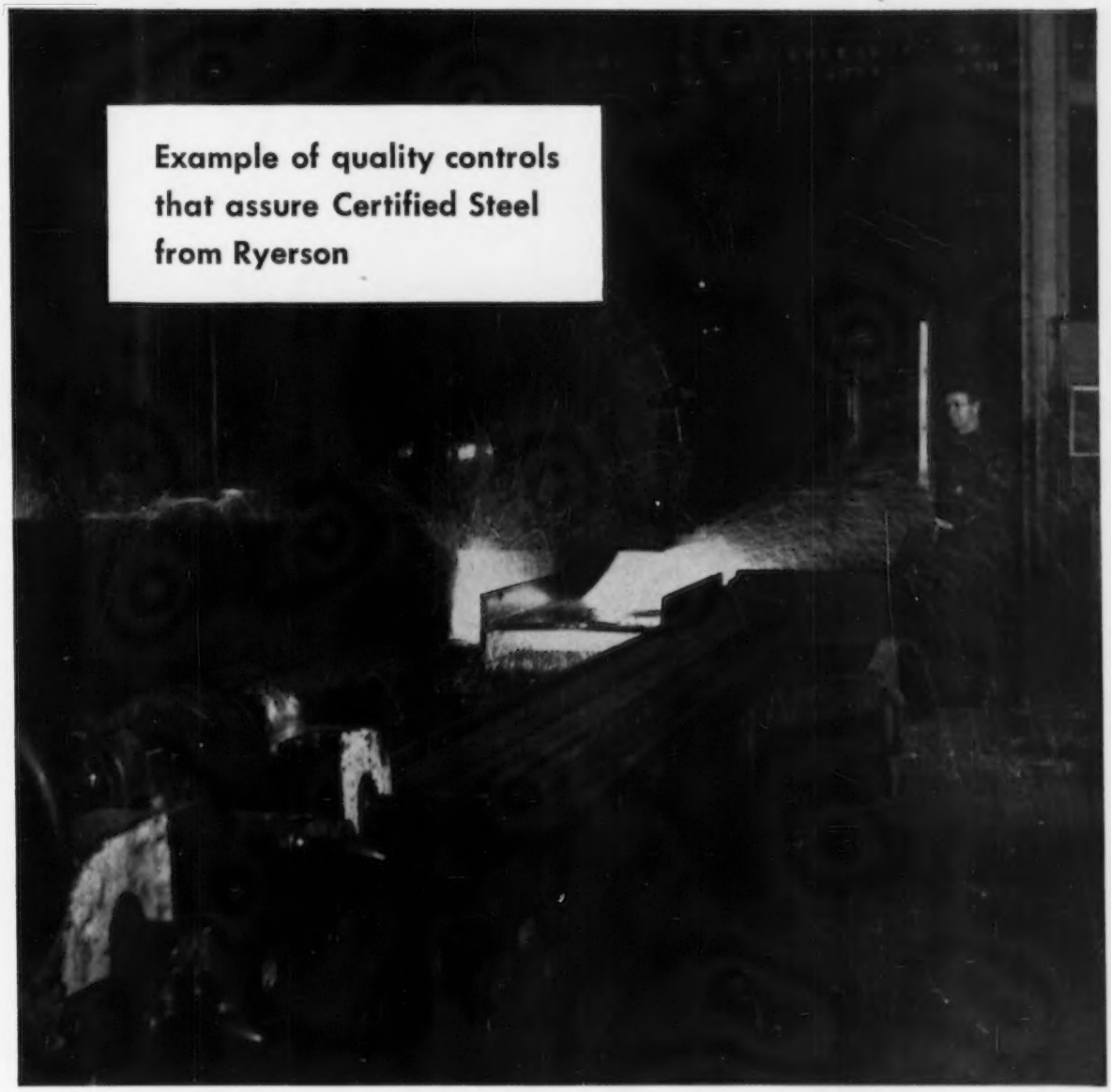
Pyrometallurgy

Process for the gaseous reduction of iron ores, with a recycle of part of the spent gas through a gas generator. This method is claimed to be more economical of fuel and lower in capital cost as compared with conventional blast furnace operation. G. R. Paschal. No. 2,793,946.

In this low-temperature method of recovering refractory metals, especially titanium and zirconium, ores or compounds thereof are reduced with an alkali metal dispersion, for example a sodium dispersion. J. W. Clegg and W. A. Meeley, assigned to Ethyl Corp. No. 2,791,499.

An economical chemical reduction process for obtaining hafnium-free zirconium from zircon by converting the hafnium and zirconium to the tetrahalide form, and then reducing the zirconium tetrahalide to a lower halide or even metallic zirconium while maintaining unchanged the hafnium tetrahalide. The two compounds are then separated, for instance by sublimation of hafnium tetrahalide. I. E. Newnham, assigned to Commonwealth Scientific & Industrial Research Organization, Australia. No. 2,791,485.

Process for direct reduction of iron ores by means of a carbonaceous material to form iron, particularly pellets of sponge iron. H. Freeman. No. 2,792,-298.



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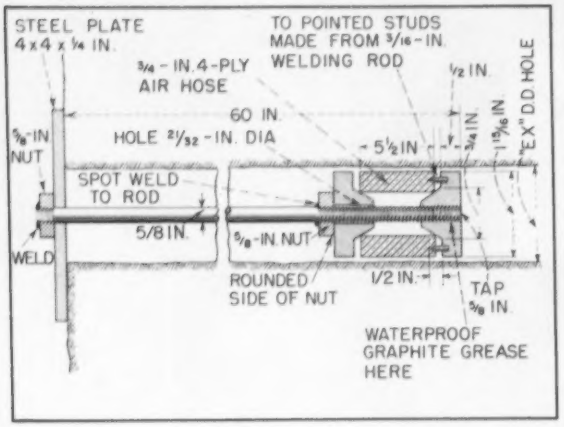
OPERATING IDEAS



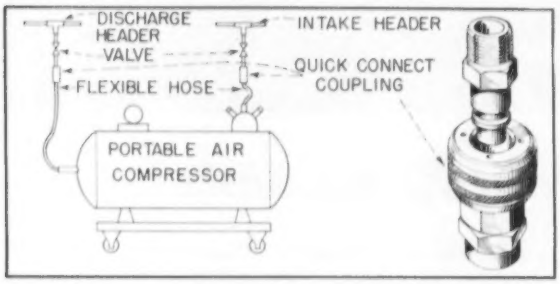
Drill Hole Plug Stops Water

NOVEL PLUG for sealing diamond drill holes underground that make considerable water, has proven very satisfactory at Empire Star Mines Co. Ltd., Grass Valley, Calif. It resembles a rock bolt in design and operation. Phil Keast, master mechanic, says he made the first one several years ago and they have resisted pressures up to 300 psi without a single failure.

They are inexpensive and easily fabricated. And they are easily handled in drift or raise. Five-foot length reaches behind any surface cracks around the opening.

Installation is simple. After plug components are assembled and all threads and moving parts lubricated with waterproof graphite grease so bolt runs easily, assembly is placed in hole. In holes making abnormal amount of water at high pressure, two men are sometimes required to push the plug into place.

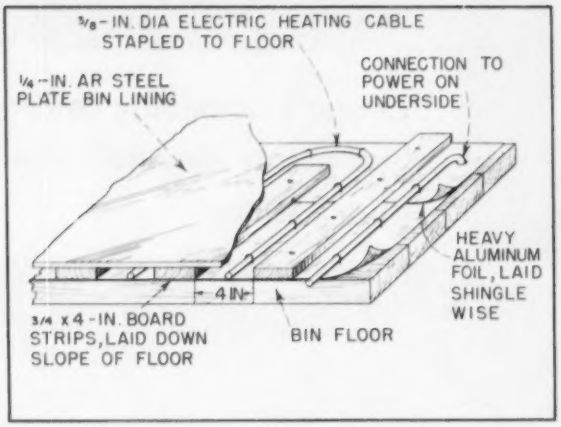
When bolt is fully inserted, nut on exterior end is turned with wrench. The action expands the rubber air hose tightly against the walls of the drill hole and stops the flow of water. The pointed studs in the tapped washer prevent the washer from turning once they stick into the end of the air hose.



Compressed-Air System Aids

PORTABLE COMPRESSORS provide flexible reserve capacity at low investment cost in multi-unit compressed-air systems according to H. B. Wayne, Woodhaven, N. Y. He mentions that many mines, mills and smelters have such systems and portable units can be tied into system at any work area where temporary demand exceeds supply.

Diagram shows typical arrangement of portable unit connected to intake and discharge headers. Flexible hose (rubber or metal) and quick-acting couplings (several variations are available in addition to one shown) make such arrangement even simpler in operation. No special tools or skilled labor is required.



Bin Heater Ends Muck Freezing

ELECTRIC RADIANT HEATING is an inexpensive answer to problems of frozen muck in bins and iced chute gates according ing to Bruce E. Allgaier, Kellogg, Idaho.

He says setup shown in sketch "was found entirely adequate during sub-zero weather when temperatures ranged from night lows of minus 20 deg F or lower to daily highs of around 15 deg F. On one occasion the highest temperature recorded over a 21-day period was minus 18 deg F. At no time during this period was any difficulty experienced in drawing muck from these heated bins.

"Prior years found us in the bins with picks and sledges or setting-off small dynamite charges as well as having continuous trouble with iced gates. All these difficulties were effectively cancelled. Further more, the muck was warm enough so that on a normal handling cycle it rarely stuck to the truck bed."

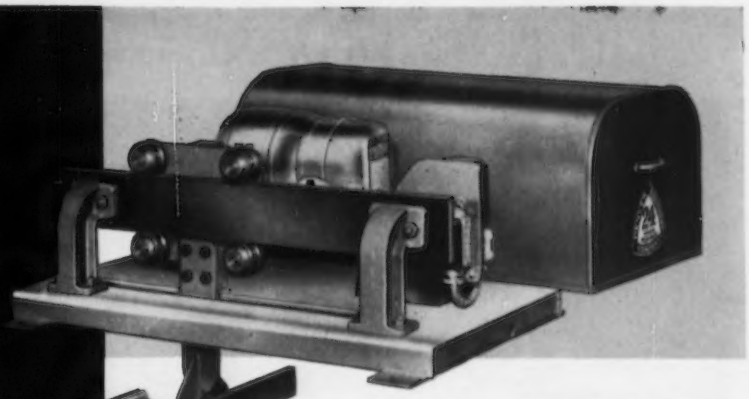
Bin structure adjoins headframe and is of wood. It consists of two adjoining bins each with one steel chute. Officials at first considered vibrators but took a dim view of their effectiveness or advisability in such a set-up. After deciding to use heat several electric heating devices were investigated. But these would have had to be installed under the floor bin in a reasonably weatherproof enclosure if any advantage was to be obtained in winter. Power consumption was considered and since six units of 2,000w each was minimum required, efficiency was not very impressive.

But when it was decided to line both bins and chutes with steel plate, it seemed an oportune time to try an electric cable heating installation under the plate—both in bin areas and around chutes. The heavy aluminum foil acts as a thermal barrier and reflects heat into the plate. The ¾-in. wood strips are laid with pitch of floor and any water seepage under plate can drain out. The strips support the plate and allow ample clearance for the ⅜-in. dia electric heating cable. Cable was stapled in place carefully to prevent crushing sheath. Wood facings were built around the projecting steel chutes with heating cable between in a similar manner.

Some 1200 sq ft of bin surface was covered with 600 ft of cable. Manufacturer claims cable draws 7w per ft at 240v when used in 120-ft lengths, making total power consumption 4,200w. Since chutes were more exposed, separate 120v circuits were wired for them. Approximately 50-ft lengths were used around each chute. Operating cost for entire installation is about $0.15 per hr (electricity costs 3.2 per kwh). But frequently heat on chute alone is enough to keep muck moving

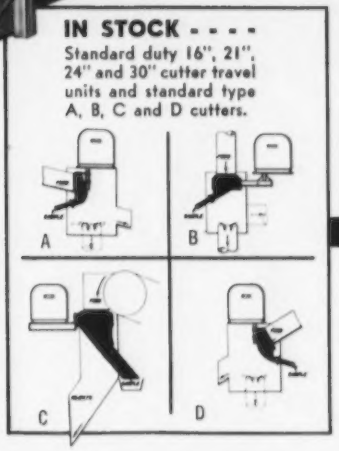
Simplicity and success led to later use of electric cable in cement shower room floor in a new "dry." It was controlled by a wall thermostat and not only was it welcomed by men but also helped heat building. A 120-ft length of cable was also installed in a 3,500-gal water tank with satisfactory results.

DENVER *Automatic* SAMPLERS



A Simple, Low Cost, Dependable and Accurate Unit— Few Moving Parts— No Maintenance.

IN STOCK - - - -
Standard duty 16", 21", 24" and 30" cutter travel units and standard type A, B, C and D cutters.



ONLY ONE LIMIT SWITCH

Simple design requires only one limit switch. Simplifies wiring circuit.

Electrical problems stemming from switches are cut one half.

GEARMOTOR DRIVE

The gearmotor drive is operated in only one direction and the cutter travel is limited by a magnetic brake. Eliminates complicated switches and wiring that is required when motor is reversed.

FRICTION-FREE CUTTER TRAVEL

Cutter is carried on ball-bearing carriage wheels that roll on rigid, cold-rolled steel track. Eliminates wearing, metal-to-metal sliding or screw contact. Carriage is driven by heavy roller chain with DOUBLE pins which eliminate eccentric load on chain.

EASY-TO-SET TIMER

Simple Telechron driven, automatic reset timer regulates sampling interval. Timer setting can be easily changed at any time by shifting the fingers on the dial. No changing of gear trains.

Individual Sampler or Complete Sampling System

Standard duty units are kept in stock. Heavy duty units suitable to carry special cutters weighing several hundred pounds are available with cutter travel to 10' and longer.

Wet, dry, dust-tight units, multi-stage sampling, continuous cutter operation or intermittant automatic operation is available.

Dimensional drawings and specification sheets are available to assist in preliminary design layouts.

H. L. MINISTER, DECO Sales Engineer with many years' mining and milling experience, is available to assist you with your problems; in sampling, or any phase of your mill operation. Denver Samplers are described in detail in Bulletin No. S1-B4. A copy will be sent you on request.

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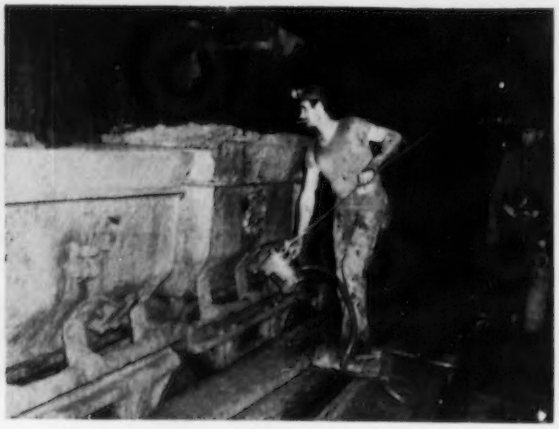

WHETHER on rotary car dumpers at open pits or on bottom dump cars in underground mines—

Vibrators Aid Dumping of Sticky Ores

WET, FROZEN OR JUST PLAIN STICKY ORE can be a headache to get out of railroad or mine cars. The Iron Ore Co. of Canada has gone a long way toward solving this problem with vibrators and chemical release agents at their Seven Islands, Quebec, rotary car dumper installation.

In the spring and fall navigation season, freezing temperatures prevail and wet ore coming down from the inland mine by rail has ample time to freeze. When cars are dumped, frozen ore clings stubbornly to sides, ends and bottoms of cars. In some instances as much as 10 tons of a 90-ton carload would hang up. As a result, reweighing was necessary and car capacity was reduced.

Although these periods of freeze-up are intermittent, when dumping up to 100,000 long tons every 24 hours such a condition can quickly knock shipping schedules and cost estimates into a cocked hat.

Iron Ore of Canada's engineers made a survey of possible solutions. Car heaters were considered too expensive and slow and caused considerable car damage. Chemical release agents were ineffective. Then it was decided to try vibratory shakers.

By mounting four Cleveland Type F air-actuated vibrators, two per car for the dual dumper on the retaining arms, the ore is successfully jarred loose. Vibrators, manufactured by the Cleveland Vibrator Co., Cleveland, Ohio, develop enough force to vibrate the whole car without damage.

Using 80-psi air, each vibrator has a 70-lb, 5-in. dia piston which hammers back and forth 1,440 times per minute with 1⅜-in. stroke. Controls are located in dumper operator's booth. When he sees ore hang-ups, a flick of the switch starts the vibrators. For chronic conditions, automatic controls can be turned on that will start the vibrators when car turns over.

Used in conjunction with a chemical release agent the vibrators efficiently and rapidly clear the cars

Sticky ore underground has been effectively combated with another type of Cleveland air vibrator (top right). Attached to side of each car—in this case, bottom dump—is a special female bracket into which a hand portable unit is placed. After car is dumped, operator transfers unit to next car.

Water Spray Granulates Slag

HIGH PRESSURE WATER jets granulated molten slag as it overflows ladle during arc-furnace tapping at Pacific Northwest Alloys ferrochrome plant near Mead, Wash. Spray is used in new equipment for recovering ferrochrome from slag produced in arc furnaces which make high carbon ferrochrome. First of four recovery units—one for each arc-furnace—was installed in February according to W. H. Swann, assistant plant manager. After granulation, belt conveyor loads slag into 2-ton skips for transport to concentrating unit. High carbon ferrochrome is separately converted to low carbon grade in vacuum furnace of the company.

Gold Film Protects Against Heat

A THIN GOLD FILM sprayed onto plastic face protectors now protects workers at Bochumer Verein AG, Bochum, a big German steel company. Layer of 0.001 mm is said to reflect 95% of heat rays without affecting transparency. Welding goggles and glass observation windows are also treated. Latter are coated with 2 grams of gold per square meter.

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for safety, speed, strength

If your operation involves haulage with locomotives and cars in the 1 to 30-ton range, it will pay you to investigate the advantages of Willison Automatic Couplers.

Willisons are *Safer*—because they couple automatically...*Faster*—because they're self-aligning...*Stronger*—because they take the full buff and pull forces without depending on intermediate parts.

Over 100,000 Willison Automatic Couplers are in daily use in mines, industrial plants and foreign railroad service because they're *safer...faster...stronger.*

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PERSONALS

Smith Barker

Cerro de Pasco Corp. has named **Walter C. Smith** to the post of consulting metallurgist of the corporation, and **Irving L. Barker** to succeed Mr. Smith as resident metallurgist. Both officials will be located in the New York office. Joining the company in 1927, Mr. Smith was assigned to the smelting and refining department at La Oroya, Peru. He developed a process for recovering and refining bismuth and has been awarded a number of U. S. patents, for separating and refining bismuth and for production of copper alloys. Mr. Barker has served 22 years in various capacities at the company's operating properties in Peru. He was appointed general superintendent of smelting and refining at La Oroya in 1951.

Raymond L. Dye has been appointed to the board of governors of the Arizona Department of Mineral Resources. He has been an active mine operator in Arizona for more than 20 years.

Donald E. Macknight, senior in metallurgical engineering at Montana School of Mines, Butte, has been awarded the Mary W. Young Westervelt Fund loan of $1,000 for one year commencing in September. The grant, one of 16 presented by the Women's Auxiliary to the the AIME, to students, is based upon scholarship and leadership potentialities.

Donald B. Muckler, general mine foreman, Oliver Iron Mining Division's Eastern Mesabi Range area, has been promoted to assistant mine superintendent at the Canton mine in Biwabik.

R. L. Larson, treasurer of Oliver Iron Mining Division for the past 7 years, has retired after 45 years of service with the company.

Warren L. Howes has resigned as manager of the Western-Knapp Engineering Co. to set up consuming practices at 1305 Hillview Drive, Menlo Park, Calif.

R. W. Diamond, retired executive vice president of Consolidated Mining & Smelting Co. of Canada, Ltd., has been awarded the Gold Medal of the Institution of Mining and Metallurgy (London) for 1956, "in recognition of his distinguished services to the mineral industry in Canada."

Dr. James Scott Long, retired chemical director of Devoe & Raynolds Co., has been awarded an honorary degree of doctor of science from Lehigh University.

Roy E. Nelson, production manager for American Gilsonite Co., has been elected vice president of the company.

Lewis A. Smith has joined the staff of the Arizona Department of Mineral Resources at Phoenix as field engineer, succeeding **Bayard J. Squire,** who is being transferred to the northern district to replace **Mark Gemmill,** who is retiring.

Dr. G. H. Charlewood, former chief geologist of the Manitoba Department of Mines and Technical Resources, has been named vice president of Heath & Sherwood Drilling, Ltd., Kirkland Lake, Ontario.

Dr. Donald S. Taylor has been elected vice president in charge of research for the United States Borax & Chemical Corp., succeeding **G. A. Connell,** retired.

John Cameron Fox has been appointed secretary of the Society of Mining Engineers of AIME, succeeding **Arnold Buzzalini,** who has resigned to resume his work in the field of geological exploration. A graduate of the School of Mines, Columbia University in 1940, where he later taught for four years, Mr. Fox was associated with Getchell Mining Co., Chile Exploration Co., New Jersey Zinc Co., Nicaro Nickel Co. and E. I. du Pont de Nemours & Co. Prior to accepting his present position, Mr. Fox was assistant manager of the mining division of American Metal Co., Ltd. He has also served as editor of *Mining Congress Journal,* and been on the staff of the *Canadian Mining Journal.*

Fox

Charles E. Melbye and **Stuart S. Merwin** have announced the continuation of consulting services as the firm of Melbye and Merwin and have announced the association of **Charles F. Arnold** with the firm, located in Golden, Colo.

Virgil W. Carmichael has been named mining engineer for Northern Pacific Ry. Co.'s Geology Division.

W. A. Arpi, development engineer at Oliver Iron Mining Division's Pilotac concentrating plant at Mountain Iron, has been appointed superintendent at the plant and **Clifford W. Miemi,** assistant superintendent at the Extaca agglomeration plant at Virginia, has been promoted to superintendent there.

Allen F. Agnew, professor, department of geology, University of South Dakota, has been appointed state geologist and director of the South Dakota Geological Survey, replacing **Dr. E. P. Rothrock,** resigned.

Kenneth E. Merkling, research engineer with Pickands Mather & Co., has been appointed chairman of the Standards Committee of the Minerals Beneficiation Sub-Section of the Minnesota Section, AIME. Other members of the committee are: **S. E. Erickson,** M. A. Hanna Co.; **M. F. Williams,** Oliver Iron Mining Div.; **W. R. Van Slyke,** Cleveland Cliffs Iron Co.

Earl M. Irving, formerly with the U. S. Geological Survey, has been named manager of Hanna Coal & Ore Corp. exploration work in Brazil with headquarters in Sao Paulo. **A. E. Walker,** chief geologist for Hanna, who has been directing exploration, has returned to the U. S.

A. E. Matson, director of beneficiation at the Cooley laboratory of M. A. Hanna Co., has retired, but will continue as consultant. **Stephen E. Erickson,** beneficiation engineer with Hanna since 1946, succeeds Mr. Matson.

Robert P. Matson, general operating engineer with M. A. Hanna Co., has been transferred to Iron Mountain, Mo., where he is now superintendent of the Iron Mountain mine, Ozark Ore Co., succeeding **F. J. Lee** who has been named general operating engineer in the Iron River district.

Frank J. Smith, vice president iron ore operations, Oglebay, Norton & Co., has retired after service with the company since 1908.

W. R. Doell, former superintendent of the Globe-Cornell mine for Globe Iron Co., has retired. Operation of the property was taken over by Pickands Mather & Co. last year and **Arthur Martini** is now superintendent.

A. J. Cayia Jr., chief engineer of Inland Lime & Stone Co., has been advanced to assistant superintendent. **Charles Atwater,** plant engineer, succeeds Mr. Cayia, and **Joseph Cherneski** has been promoted to general mill foreman.

Bellano Ware

International Minerals & Chemical Corp. has elected **William Bellano** vice president in charge of engineering. He joined IMC in 1953 as chief mining engineer of the engineering division and later became the division's general engineering manager and production manager of the Phosphate Chemicals Division. For the past year he has been director of mining and exploration. **Thomas M. Ware,** administrative vice president, has been elected a director of the company succeeding **David M. Milton,** retired after 15 years of service on the board.

Here's why

Euclid TC-12

Twin-Power Crawlers

give you MORE WORK-ABILITY

With 436 hp, independent track drive and many other advanced design features, the TC-12 has set completely new standards of performance for big tractor work.

Your Euclid Dealer will be glad to provide specifications and performance data on work similar to yours.

The TC-12 has speed—up to 7.8 mph forward or reverse—but that's not all. Pivot turns (one track forward and one reverse at the same time) plus changing of direction and range under full power without loss of momentum save considerable time during the tractor's daily operation.

Two engines with a total of 436 h.p. (413 net h.p. at drive train) make this Euclid "Twin" the world's most powerful crawler. Being more powerful, the TC-12 offers additional benefits, such as faster work and longer engine life, since the engine often operates at less than full capacity without strain. And, the reserve power permits handling the toughest tractor job.

Pivot turns with the TC-12 take less space and time. Changing directions on the go with Torqmatic Drives makes maneuvering into position quicker. Split-half construction gives better traction on uneven ground.

Clutching and shifting are eliminated with the TC-12 "Twin". There's 24-volt push-button starting and instant response to directional levers, range selector and hand throttle levers, all of which are conveniently located to allow complete freedom of the operator's right hand for control of attachments.

Many design features contribute to long life and easy servicing. Location of radiator behind operator reduces damage and improves cooling. Track tensioning and recoil system are automatic. All engine accessories are readily accessible from outside the engine compartment. Rollers can be removed without breaking track. Engines, Torqmatic Drives, and planetary final drives can be removed without disturbing the other components.

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Euclids are your best investment.

EUCLID DIVISION,
GENERAL MOTORS CORPORATION, Cleveland, 17, Ohio

Euclid Equipment

FOR MOVING EARTH, ROCK, COAL AND ORE

PERSONALS (*Continued*)

Lutjen

Patten

George P. Lutjen, managing editor of *Engineering & Mining Journal* since March 1955, has been named district manager for McGraw-Hill Publishing Co. in the New England district. In his new capacity, Mr. Lutjen will serve mining equipment manufacturers as advertising representative for *E&MJ, Coal Age* and *Keystone Coal Buyers Manual* succeeding **John W. Patten,** who is now heading the new Denver, Colo., office of the Pacific district.

A graduate of Columbia College in 1941, Mr. Lutjen received his B.S. degree from Columbia's School of Mines in 1942. After graduation he joined Freeport Sulphur Co. as a mining engineer and remained in the Louisiana area with that firm until 1949, except for three years with the U. S. Marine Corps, in the South Pacific and China. Duties at Freeport included all engineering services to the production department and supervision of production research projects.

Mr. Lutjen joined the staff of *E&MJ* in January 1949 as an assistant editor, becoming associate editor in 1950. He joined the U. S. Atomic Energy Commission in 1951 as a mining engineer with staff responsibility for exploration activities on the Colorado Plateau and returned to *E&MJ* in March 1952. In the course of his career with the editorial staff of the magazine Mr. Lutjen has traveled extensively throughout the mining areas of the United States, eastern Canada and the Caribbean.

With Alvin W. Knoerr, Mr. Lutjen received the Jesse H. Neal award for outstanding journalism in 1954 and 1956 and the Industrial Marketing award for technical journalism in 1956 and 1954. He is co-author, with Mr. Knoerr, of the book "Prospecting for Atomic Minerals."

Felix E. Wormser, Assistant Secretary of the Interior for mineral resources, has submitted his resignation, effective June 15. Mr. Wormser is scheduled to return to the St. Joseph Lead Co. where he had been vice president before taking his post in Washington over four years ago. In accepting Mr. Wormer's resignation with regret, President Eisenhower indicated that he understood the personal reasons that led to Mr. Wormser's decision.

Wormser

R. W. Whitney Jr. has been transferred from the Hanna Co. nickel operations at Riddle, Ore., to the Mesabi Range where he is assistant superintendent at the Mississippi group at Kunatin.

Allison Butts, professor of metallurgy at Lehigh University, has retired after 41 years of service on the faculty. Prior to joining the Lehigh faculty in 1916, he was a research chemist for the United States Metals Refinery Co.

Howard G. Schoenike has announced his resignation as production geologist for the Bariod Division of National Lead Co. in order to devote full time to domestic and foreign consultation as a mining geologist with headquarters at 4039 Turnberry Circle, Houston, Tex.

George G. Griswold Jr. has been awarded honorary membership in the Montana Society of Engineers. He is a consulting metallurgist, author of a number of technical papers and developer of several flotation processes used in separating complex ores.

George C. Heikes has joined Continental Uranium, Inc., as manager of mineral resources, a newly created staff position as a part of the company's program to further expand its mining activities. Mr. Heikes was formerly chief mining engineer for the National Lead Co. During World War II, he served as director of the zinc division and, later, the aluminum magnesium division of the War Production Board. After the war, he was successively chief of the mining branch of the ECA Mission to Greece; recently he served as a consultant to mining companies.

Heikes

L. G. Woodworth, assistant superintendent, Newport mine, Pickands Mather & Co., has been transferred to the Peterson mine as assistant superintendent. **Albino J. Cigallio,** assistant superintendent at Anvil-Palms, is now assistant superintendent at Mauth Mining Co., Ironwood, also operated by Pickands Mather.

Degrees of professional engineer have been awarded by Montana School of Mines to **Plato Malozemoff,** president of Newmont Mining Corp.; **Frank H. MacPherson,** general manager, vice president and director of Dulaney Mining Co.; and **Joseph T. Roy,** general manager, Selby, California plant, American Smelting & Refining Co.

Charles D. Preusch has been named chief metallurgist, Spaulding Works, Crucible Steel Co. of America. He was formerly foundry metallurgist.

Wesley G. Johnson, mining engineer with Inland Steel Co., has been transferred to the Mesabi Range.

Philip R. Bradley Jr., consulting engineer to the Alaska-Juneau Gold Mining Co. and **William C. Browning,** consulting mining engineer and general manager of the Golden Queen Mining Co., have been reappointed by California Governor Goodwin J. Knight to the state mining board for terms ending January 15, 1960. Mr. Bradley is president of the Atolia Mining Co., and the Mother Lode Mining Association.

Dr. Edwin G. Koch, professor of chemistry at Montana School of Mines, Butte, Mont., was recently named president of the college. Dr. Koch received his Ph.D. in chemistry from the University of Illinois in 1932 and had taught at the University of Tennessee in Knoxville and the University of Texas before coming to Montana School of Mines in 1946. At various times he was employed as a research chemist by Hercules Powder Co., Shell Oil Co., Amalgamated Sugar Co. and Atlas Powder Co.

Koch

OBITUARIES

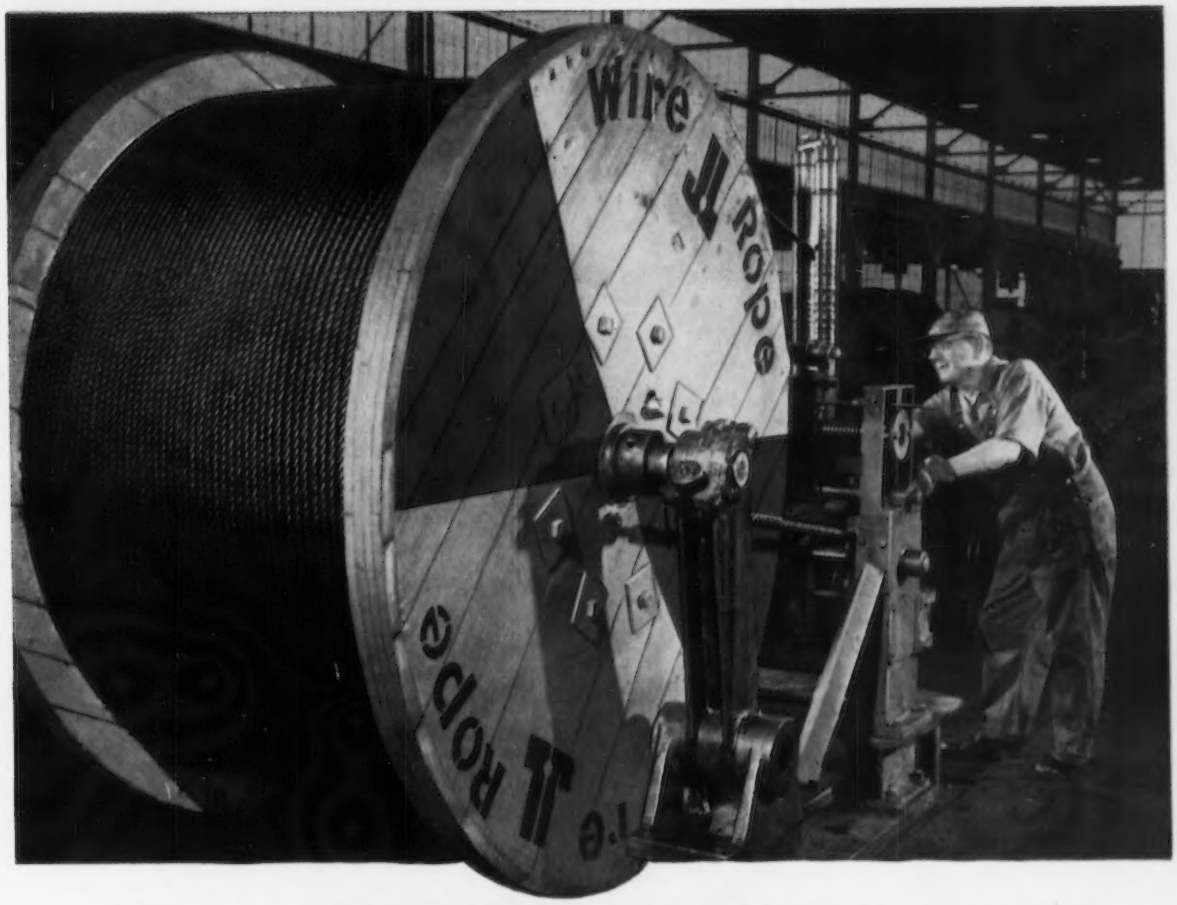
Joseph M. Johnson, 53, assistant general superintendent for Oliver Iron Mining Division's eastern district, died April 24. He joined Oliver in 1928 and in 1944 was made assistant superintendent in charge of the Eveleth mines. In 1946 he became superintendent of the Spruce, Hull-Nelson open pits and the Spruce underground mines. He was promoted to assistant general superintendent in 1952.

Robert M. Fryberger, 49, partner in the Rhude & Fryberger Mining Co., was killed in an automobile accident April 10, while driving from Hibbing to his home in Duluth, Minn.

George F. Zoffman, 77, president and chairman of the board of Duval Sulphur & Potash Co., died June 5 at Methodist Hospital, Houston, Tex. A graduate of Stanford University, majoring in mining engineering, Mr. Zoffman joined Duval in 1929 as general manager after 13 years in Mexico with Cinco Mining Co.

Richard F. Grant, 77, retired director of M. A. Hanna Co., died May 26 in a Gaylord, Mich., hospital after a brief illness. He joined Hanna in 1909 and became a partner in 1917 and a vice president in 1923. In 1928 he resigned as a Hanna vice president to become president of Lehigh Valley Coal Corp., a post he held until 1933. Until a few years ago he continued to hold a Hanna directorship.

Harry T. Patterson, 46, operational manager of the Harbor Island and Kure Beach Corrosion Test Stations of International Nickel Co., Inc., died suddenly May 27 at his home in Wilmington, Del.



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NEW BOOKS

Mining Year Book 1957, by Walter E. Skinner. New feature of the 1957 issue is the world production tables for gold and base metals by countries. Book also contains complete and up-to-date information on 951 international mining companies. Mining engineers and mine managers section contains 1300 names and addresses. The buyers' guide section lists 680 international manufacturers. Published by Walter E. Skinner, 20, Copthall Ave., London, E. C. 2. 825 pp. Price $7, post free abroad.

Mining Journal Annual Review 1957. Contains an annual survey of mining progress covering every aspect of mining, milling, smelting, economics and financial. This issue contains about 150 technical articles, economic reviews and country by country surveys. Published by *Mining Journal,* 15, Wilson St., London, E. C. 2. Over 300 pp. Price $1.50 to non-subscribers.

Phase Diagrams in Metallurgy, their development and application, by Frederick N. Rhines. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 340 pp. Price $12.

Elastic Waves in Layered Media, by W. M. Ewing, W. S. Jardetzky and Frank Press. In connection with section on geophysical prospecting, the groundroll problem, refraction and reflection in layered media, off-shore prospecting applications and waves in boreholes are discussed. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 374 pp. Price $10.

Flotation Plant Practice, by Philip Rabone. Fourth edition. Published by Mining Publications Ltd., Salisbury House, London, E. C. 2. 246 pp. Illustrated in 246 pp. Price 40s.

Glacial and Pleistocene Geology, by Flint. Maps, references and text. Published by John Wiley & Sons, Inc. 440 Fourth Ave., New York 16, N. Y. 544 pp. Price $12.50.

Maintenance Engineering Handbook, by L. C. Morrow and a staff of experts. In 16 sections. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Illustrated in 1,528 pp. Price $20.

Reports and Bulletins

21st Annual Meeting of Industrial Hygiene Foundation Report. Published by Industrial Hygiene Foundation of America, 4400 5th Ave., Pittsburgh 13, Pa. 281 pp. Price $5.

Ore Microscopy, by Sigmund L. Smith. Miscroscopy examination method for the metallurgist, as developed by the author at Arizona College of Mines. Fine ore, thin section and polished microscopy are covered. Published by Sturm and Smith, P. O. Box 4063, Tuscon, Ariz. Price $10.

Iron and Steel Works of the World, by H. G. Cordero. Second edition. Comprehensive, world-wide review of the iron and steel industry. Includes more than 1200 works on five continents and in nearly fifty countries. Published by Quin Press Ltd., Birkett House, 27 Albemarle St., London, W. 1. 800 pp. Price £4, post free.

The Casting of Steel, by W. C. Newell. Considerable detail on British foundry practice. Published by Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. Illustrated in 594 pp. Price $27.50.

Handbook of Rigging, by W. E. Rossnagel. Second edition. How to handle any step in any rigging operation. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. Illustrated in 344 pp. Price $6.50.

Crystallography to Students of Mineralogy and Geology, by George Tunnell and Joseph Murdoch. Diagrams, drawings, tables and text in 54 pp. Published by William C. Brown Co., 215 W. 9th, Dubuque, Iowa.

BOOK PRESENTED on this page are available through the publishing house mentioned in connection with the individual literature. *E&MJ* does not sell or offer any literature presented here, unless specifically noted.

Unit Operations of Chemical Engineering, by Warren L. McCabe and Julian S. Smith. Written at the undergraduate level, this text covers unit operations of chemical engineering from both a practical and theoretical standpoint. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Illustrated in 945 pp. Price $10.50.

Maine Pegmatite Mines and Prospects and Associated Minerals. Minerals Resources Index No, 1. Compiled by John Rand, state geologist, the booklet should assist in locating and developing Maine's mineral resources. It lists 184 pegmatite occurrences of feldspar, quartz, mica, beryl, spodumene, tourmaline and many other minerals. This booklet is the first time that the known mineral deposits have been published. Published by Department of Development of Industry and Commerce, Augusta, Maine. Tables, lists and maps in 43 pp.

•Application for the following free literature should be made to the address listed below. Because of the limited editions, only one copy of any particular edition can be sent to any one person, and only a modest number of a variety of publications can be furnished to an applicant. Please order only those publications actually needed. Publications Distribution Office, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

Report of Investigation 5274, Recovery of Kyanite and Sillimanite from Florida Beach Sand, by J. S. Browning, B. H. Clemmons and T. L. McVay. 12 pp.

Report of Investigation 5275, Producing Magnesium by Silicothermic Reduction, by F. E. Block and T. T. Campbell. 29 pp.

Report of Investigation 5284, Leadville Drainage Tunnel, Second Project, Lake County, Colorado, by M. H. Salsbury. Illustrated in 50 pp.

Report of Investigation 5291, Diamond Bit Performance in Schist, by D. M. Hausen and A. E. Long. 14 pp.

Report of Investigation 5298, Volatilization of Tin Chlorides from Slimes, by K. K. Kershner and A. A. Cockran. 10 pp.

Report of Investigation 5305, Preparation of High-Purity Electrolytic Chromium, by P. M. Gruzensky and F. E. Block. 11 pp.

Report of Investigation 5320, Copper Mines and Prospects Adjacent to Landlocked Bay, Prince William Sound, Alaska, by Miro Mihelich and R. R. Wells. 21 pp.

Report of Investigation 5239, Separation of Tantalum-Columbium by Solvent Extraction, by K. B. Hogbee and J. R. Werning.

Report of Investigation 5311, Consumable-Electrode Arc Melting of Titanium and Its Alloys, by R. W. Huber and I. R. Lane Jr. Illustrated in 36 pp.

Report of Investigation 5312, Beneficiation of Iron-Copper Ores from Kasaan Peninsula, Prince of Wales Island, Alaska, by R. R. Wells. E. G. Erspamer and F. T. Sterling. Illustrated in 15 pp.

Report of Investigation 5313, Examination of Copper-Lead-Zinc Deposits, Cabarrus and Union Counties, North Carolina, by A. L. Peyton. Illustrated in 13 pp.

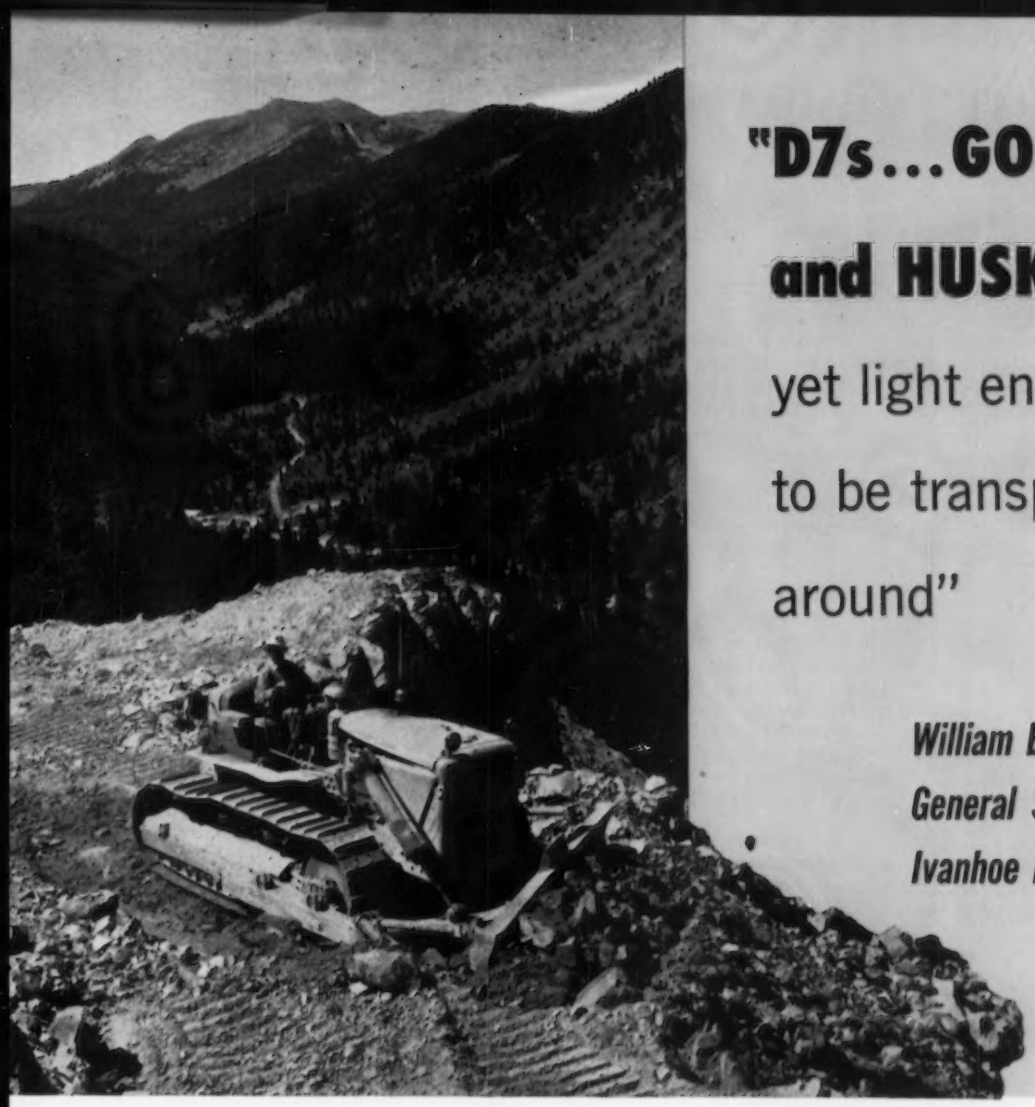
Report of Investigation 5315, Electrorefining of Titanium Metal, by J. R. Nettle, D. H. Baker Jr. and F. S. Wartman. Illustrated in 43 pp.

Information Circular 7767, Potential of Heavy Mineral-Bearing Alluvial Deposits in the Pacific Northwest, by A. J. Kauffman, Jr. and K. D. Baker. 36 pp.

Information Circular 7768, Sampling Deep Ore Deposits by Rotary Drilling and Methods of Surveying and Controlling the Direction of Drill Holes, by R. R. Trengove and A. C. Johnson. 15 pp.

Information Circular 7774, Mining Methods and Costs at the Westside Mine of Eagle-Pitcher Co., Cherokee County, Kansas, by S. S. Clarke. 20 pp.

Information Circular 7775, Use of Prestressed Precast Shaft Supports, Banner Mine, Lordsburg, N. M., by A. D. Look and L. G. Anderson. 15 pp.



"D7s...GOOD and HUSKY, yet light enough to be transported around"

William B. Tobey
General Superintendent
Ivanhoe Mine

Two durable CAT* D7 Tractors put in a full 16 hours of productive work each day at Ivanhoe Mine, near Glen, Montana. Here are some of the jobs assigned to these rugged workhorses:

ONE—They strip limestone overburden

TWO—They feed overburden to shovels

THREE—They clear large, granite boulders from ore

FOUR—They clean up ore after blasting

"The D7s," says William B. Tobey, general superintendent, "are good and husky, yet light enough to be transported around. They do a good job in the pit and in rock . . . they do better than any other type of equipment we could use."

Tungsten has been mined since 1952 at Ivanhoe Mine, owned and operated by the Montana Tungsten Division of Minerals Engineering Co. Production is about 850 tons of ore a day with a two-to-one ratio of overburden to ore. Elevation of the mine is 7,000 feet.

The D7 is designed to give you top production no matter what the climate, elevation, season or job. Rated at 128 HP (flywheel), its four-cycle diesel engine gives you a longer power stroke resulting in smoother, more efficient operation than in two-cycle engines. Fabricated steel steering clutch case and frame unit, hardened precise-machined transmission and final drive gears and the Caterpillar oil clutch make these tractors ideal for rugged mining duty.

Your Caterpillar Dealer backs every tractor with quick, efficient service and quality factory parts. Call him and name the date—he'll demonstrate on *your* job.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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WANTED— THE HARD WORK

WASHINGTON IMPACT

Highlights

MERGER CLIMATE—The Supreme Court decision in the Du Pont-General Motors case highlights Washington's anti-merger climate. As strong as the ruling is, it only sharpens what was already a well defined trend.

The basic point of significance in the Supreme Court's order to divest Du Pont of its GM holdings is the application of anti-merger laws to vertical, as well as horizontal, combinations. This means simply that the court will consider mergers of suppliers and customers, as well as marriages of competitors, in light of their effect on competition and "tendency to create a monopoly."

The decision may well give pause, therefore, to large suppliers of basic raw materials, such as metal and mineral ores, who are considering merging with processors, refiners, smelters and other of their "customers."

Again, the Du Pont ruling must be considered along with other Government "directional signals" to management. One is the Justice Department's pre-merger notification bill, solidly backed by Attorney General Herbert Brownell and President Eisenhower, which would require companies considering mergers to let Justice Department and the Federal Trade Commission have a chance to pre-view the marriage from an antitrust angle, 60 days in advance. The measure is given a good chance of passage, and this fact points up another indicator—Congressional sentiment. House small business committee chairman Wright Patman (D.-Tex.) is spearheading a drive to get both Justice and Federal Trade Commission to stem the merger tide.

HIGHER FREIGHT RATES ARE COMING—Interstate Commerce Commission has already granted interim raises of 7% to eastern and western railroads, 5% to southern roads. Eastern and western roads want another 15% boost, southern roads are asking an additional 10%. Upshot is likely to be a 15% total increase for all roads, with eastern roads perhaps getting slightly more in addition. Trucking and shipping lines are a sure bet to follow suit.

PHOSPHATE ACREAGE—Legislation to increase the allowable phosphate acerage held by any one company within a single state boundary to 10,240 now looks like a good bet to pass Congress. The bill would not change the total limit allowable in the U.S., which would remain 10,240 acres.

INTERNATIONAL INVESTMENT—Robert L. Garner, president of the new International Finance Corp., sees metal and mineral mining as a basic venture for the international private investment IFC is out to stimulate. Agency's first, a $2-million stake in Brazilian heavy electrical equipment manufacturing facilities of Siemens Co. of West Germany, was announced last month. Future investments will include mining and factory projects—primarily in Latin America, but also in Africa and Asia as well. IFC will act as a clearing house, using both its own subscribed funds (now about $100-million) from World Bank member nations, plus private capital it can find in the U. S. and Europe, to buy convertible debentures which it will later sell. The idea is to stimulate private investment around the world.

Garner, incidentally, joins a growing list of business observers who foresee a big increase in international investment generally.

Garner thinks the international investment of the future will take on a distinct joint-venture flavor. In other words, instead of private entrepreneurs in one country exploiting the natural resources of an underdeveloped area, they will team with investors from several other countries to form an international company. This method, Garner points out, not only pools the resources and know-how of several nations to the advantage of the under-developed area, but also cuts the charge of colonialism, since no one country controls the project.

This view ties in with those of U. S. Steel's Roger Blough, who recently predicted a swing to joint-international investment, particularly in natural resources development projects.

Long Range Mine Plan Faces Capitol Gantlet

THE "SEATON DOCTRINE" long-range mining program faces a complicated series of stresses and strains in Congress. The upshot is that no new mining law can squeeze by Congress this late in the session, and chances are not much better for next year.

The program in actual bill form reached the Interior Committees on Capitol Hill only late last month, nearly a month after it was first released. As written it includes no significant changes from the original outline, except that the Interior Department is now asking its second alternative proposal for a hike in lead and zinc import duties. This is the one which would substitute excise taxes for tariffs on a sliding scale tied to domestic prices. If lead fell below 15c, for example, under the second alternative the duty would be 3c for metal, 2c for ore, instead of 3 1/16c and 2c called for in the combined tariff-tax under the first alternative. Throughout, the second alternate schedules mean a slightly lower duty than the first.

The first hurdle the program faces has been set up within the Administration itself. As Seaton told the Senate Interior Committee last month, the White House, Treasury, State and Commerce Departments, the Pentagon and ODM will not unanimously support any stronger program than the one submitted. Therefore, if the mining committees on Capitol Hill try to make it much stronger, it will lose the Administration support it now has.

The second hurdle is the attitude of the mining industries. So far, reaction in the field has been highly unfavorable. Reflecting this pressure, mining-state Congressmen have vowed to amend the program to include more Government help for more metals and minerals.

The third obstacle is Congress' budget-cutting mood. While the new program would cost only about $6-million additional per year over and above what the Government is now spending to support domestic mining, many Congressmen are talking in terms of absolute reductions, rather than relatively smaller increases in Federal spending. This mood won't ease off next year in the election session of Congress—if anything, it will sharpen.

Some mining-state Congressmen, on the other hand, agree with Seaton that the new doctrine, despite its bearish outlook will mean something to many miners. For one thing, increased research and development activity on the part of the Interior Department now has a solid stamp of approval in Washington.

Also, Seaton convinced a number of Interior Committeemen that he will review and beef up such flexible supports as bonus payments, limited purchases, modest tariff protection, and tax benefits

on a case-by-case basis as the need arises.

The first test of this flexibility of the new program will come as a result of Congress' failure to vote money already authorized for purchases of tungsten (see below). If the House also kills money for the other three minerals included in the department's stopgap purchase program, Seaton is committed to review their market situations as well.

Over-all, the Seaton Doctrine represents an initial attempt to tie together piecemeal Government aids in a precedent-setting package.

Meanwhile, Senate Interior Committee chairman James Murray (D-Mont.) is determined to hold extensive hearings—not only on the Seaton Doctrine, but on his own direct subsidy plan as well.

Minerals Purchase Bill Takes Another Beating

ONCE AGAIN Congress has moved to cut the Government's stopgap purchases of tungsten, fluorspar, asbestos and columbium-tantalum off at the pockets.

Late last month the lower chamber voted 156-47 to slice all minerals purchase money out of the third 1957 supplemental appropriations bill. The vote knocked out not only the $30-million originally scheduled, but a compromise $10-million which House Interior Committee chairman Clare Engle (D-Calif.) offered as a substitute. Senate agreed.

Latest vote means simply that the program's supporters on both sides of Capitol Hill have given up on trying to get any more money for tungsten buys. It is tungsten that drew the most vociferous House opposition, on grounds that defense requirements for that item will not be as heavy over the next few years as industry has claimed.

This is the third time the House has refused the $30-million scheduled as the second installment in the $91-million program authorized by Congress last year.

Mining-state Senators now have dropped all attempts to include tungsten in the remainder of the program. Columbium-tantalum, too, has been let go. Senate Appropriations Committee is now trying to substitute a $6.7-million appropriation for fluorspar and asbestos.

Under a ruling by the U.S. Comptroller General, this money could then be used beyond the end of fiscal 1958, through the full calendar year next year.

Senate forces are hopeful the House will accept this compromise. If the lower chamber does not, it will put a new burden on Interior Secretary Fred Seaton's flexible new long-range program (see above), since he has testified that the long-range program would be reviewed with an eye to covering any situation arising from a Congressional failure to vote money for the four-mineral stopgap program.

In any case, Seaton is obligated to review the tungsten situation.

Labor This Month

MINE-MILL TRIMS LEGAL TROUBLES: The recurring court fights faced by the International Union of Mine, Mill and Smelter Workers are closing up one by one. And, surprisingly, they're ending in favor of MMSW—or at least they lean in that direction. The mine union is, or has been, on the defensive in a number of cases. But, so far, its record is almost 100% successful. Two new decisions are boosting that record.

- The Supreme Court's ruling that former MMSW officer Clinton Jencks should receive a new trial was a big boost to Mine-Mill fortunes. Jencks had been convicted for filing a false non-Communist affidavit, but the High Court says he was illegally convicted because the Government didn't furnish the defense with documents used in the charges against Jencks.
- The High Court, two weeks later, turned over the convictions of 14 California Communists who had been given jail terms of five years on charges of attempted overthrow of the U.S. Government. None of these officials is connected with the mine union but just the legal reversal in this area is a score for the Mine-Mill position.

The newest legal developments, indicating a reversal in the trend that went against defendants in this field for a number of years, doesn't end all of the mine union's troubles. There are still two important—perhaps the most important—decisions still to come. One involves the Government's case against the non-ferrous union before the Subversive Activities Control Board, charging that it is infiltrated with Communists. The other is the indictment of Mine-Mill officers who are accused of filing false non-Communists oaths under the Taft-Hartley Act.

However, if the latest Supreme Court decisions are a sign of the times, Mine-Mill can expect to fare much better than it had anticipated when the current cases came up. Whatever the final outcome, the pressure is being eased on MMSW. In view of the long legal haul still ahead, this is a welcome relief at union headquarters.

SHORING UP FALLING PRICES: The drop in lead and zinc prices has resulted in an unusual non-ferrous industry-union alliance. Both sides are now supporting a limited import plan for metals. In almost any given situation, Mine-Mill could be found on the opposite side from the Colorado Mining Association. However, because of the decline in domestic market prices and the closing of key mines to throw union members out of work, MMSW is changing its position. Traditionally opposed to tariffs, Mine-Mill now favors a plan that would boost taxes on imports of lead and zinc if domestic prices fall below a certain level.

Mine-Mill, following a recent meeting of its executive board, issued a blast at the Eisenhower Administration's minerals program. It is following up this position with a lobbying attack in Congress while, at the same time, supporting the Metcalf import tax measure.

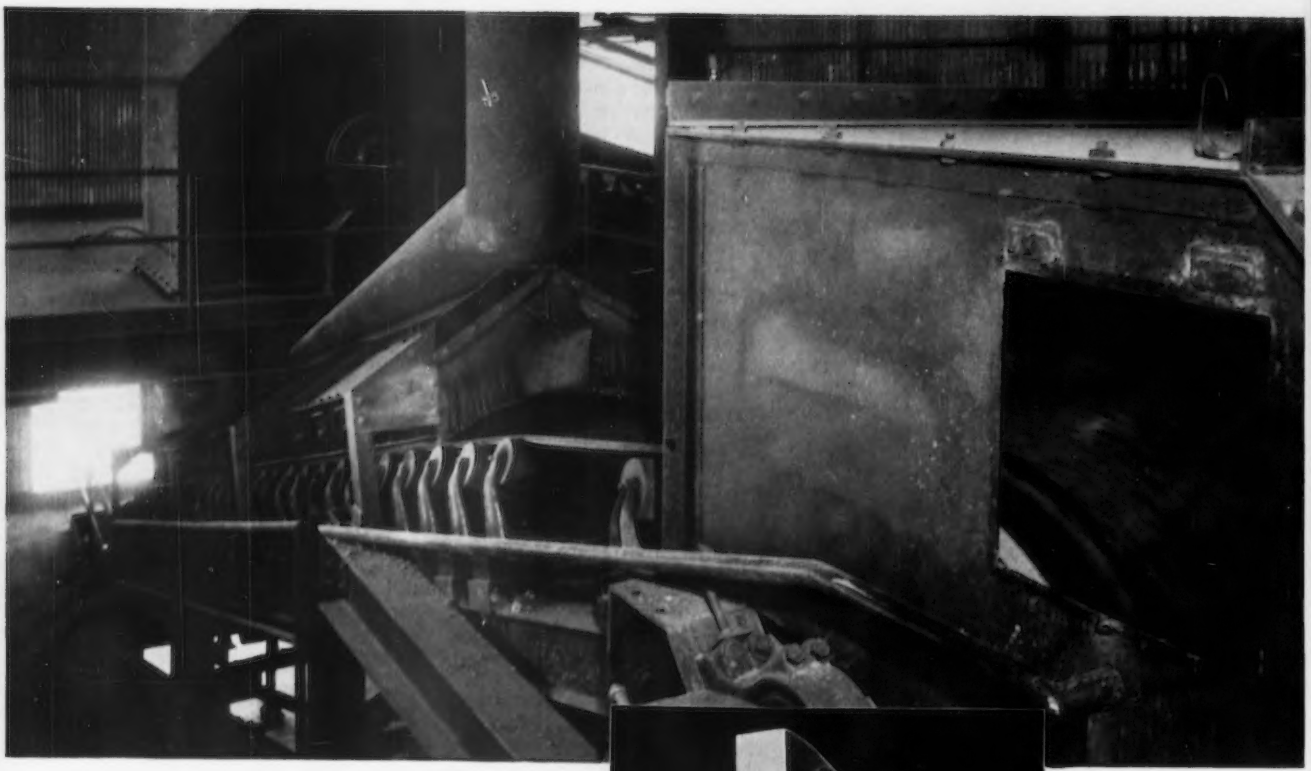
A BOOST FOR ARBITRATION: The Supreme Court has cleared the air of some confusion surrounding the legality of arbitration clauses in labor-management contracts. An estimated 90% of such agreements contain clauses sending disputes to arbitration but, until now, it has been a recurring question whether these provisions can be enforced. The Supreme Court says "yes." Under the ruling, either party to an arbitration clause can seek compliance in the courts through the Taft-Hartley Act.

But, this doesn't settle the matter entirely. It's one thing to win a court test over arbitration; it's another to get the reluctant party to go all the way through arbitration processes. One side, for instance, can agree to arbitration and then fail to agree on a mutual referee. While, technically, the clause may be followed, it still can be effectively avoided. Too, there are conflicting state rulings on the subject.

In addition, one of the toughest problems in arbitration is not the process itself, but the question of just what is to be arbitrated. Unions and management frequently disagree on just what constitutes a dispute or grievance that should go to an outside referee. Management will often argue that the dispute falls under management prerogative. Therefore, more test cases will be needed.

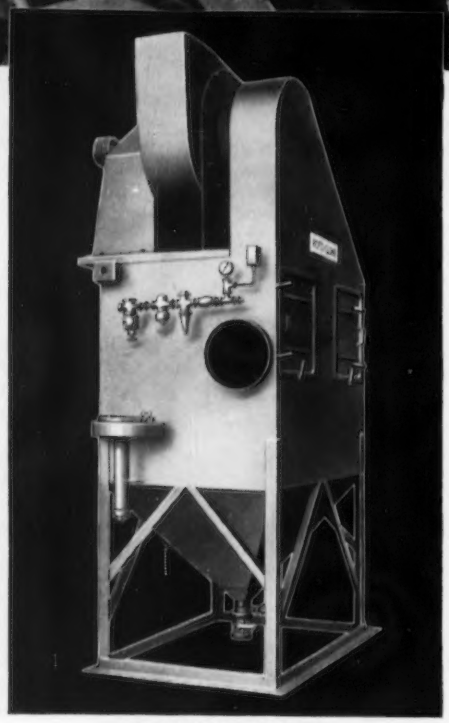
ORE-PROCESSING

.....RIGHT...



AN INDICATION OF ROTO-CLONE ACCEPTANCE:

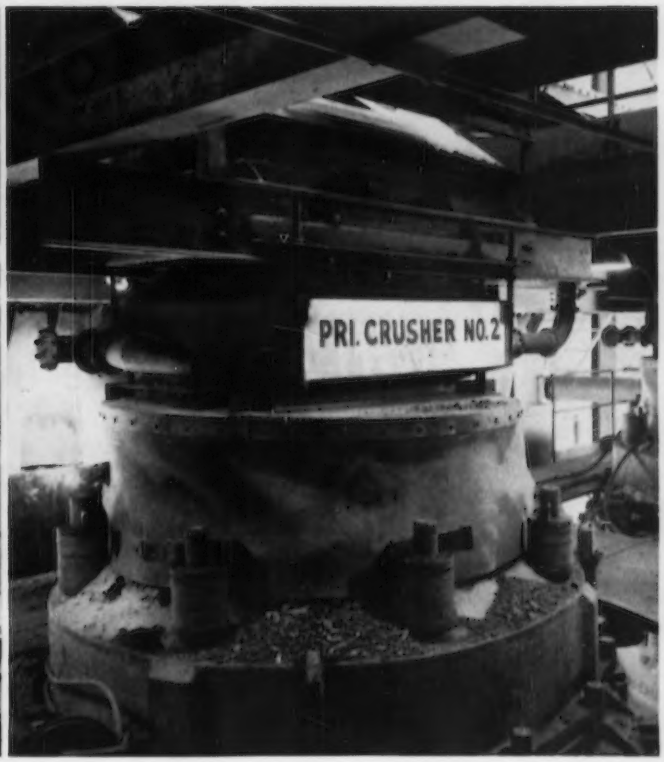
- *1,100,000 cfm at thirteen copper mining companies*
- *460,000 cfm at fourteen uranium milling operations*
- *1,900,000 cfm at five taconite concentrating plants*
- *2,508,000 cfm in coal mining and preparation plants*



AAF TYPE N ROTO-CLONE
Hydro-static Precipitator

DUST-PROOFED BY AAF

...DOWN.....THE LINE



Transfer, screening, crushing operations kept dust-free by Type N ROTO-CLONES

AAF ROTO-CLONES in this modern processing plant are "riding herd" on ore wherever it goes. From the first transfer point, through screening, crushing, and all the way to fine ore storage, the wet-collecting Type N's are doing a continuous dust collection job.

The rugged Type N is made-to-order for this kind of work. Its high cleaning efficiency results from the combined action of centrifugal force and the thorough intermixing of water and dust-laden air. It requires small space, features constant exhaust volume and maintained performance over a wide range of operating conditions.

And the Type N ROTO-CLONE has *proved* its mettle in literally hundreds of mining operations. For complete information, call your local AAF representative or write direct for Type N ROTO-CLONE Bulletin 277.

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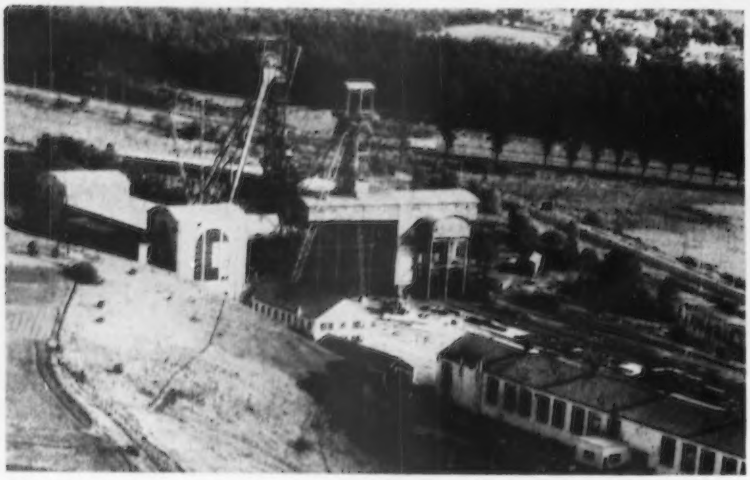


BAZAILLES iron mine in Lorraine. There are 32 other properties in the district.

France Plans Iron Ore Increase

FRANCE WILL BE PRODUCING 35% more iron ore in 1961 than in 1956 without increasing the working force, if the French iron-mining industry has its way.

This goal has just been set by the industry as its contribution to the third French five-year modernization plan, now being drawn up by government and industry officials.

This will mean production of 70-million metric tons in 1961, compared to over 52-million last year. To achieve this end, the industry will spend 40-billion francs ($114-million), not including investments in workers' housing. Rolling stock will be modernized, loading will become entirely mechanized and storage capacity will be doubled.

French iron mines already have a solid record of rising productivity behind them. Output per worker per day is now 75% higher than in 1938—in spite of serious damage to the mines during the war years. The modernization which made this possible—carried on intensively from 1946—cost the industry 46-billion francs ($131-million).

The French iron mines are high in world importance, after those of the U.S. and the USSR. Almost 93% of the country's ore production comes from the Lorraine Basin in northeastern France, while the rest is provided by a sprinkling of mines in the northwest (6.6%) and the Pyrenees (0.6%).

Reserves of the Lorraine mines amount to 6-billion metric tons, while those of the northwest and the Pyrenees have reserves of 2 billion. In terms of iron content, the French mines hold reserves of 2.7-billion tons—enough to cover almost all needs of the French steel industry for 75 years to come.

Approximately 40% of French iron-ore production is exported to the Saar, Belgium and Luxembourg, while small quantities go to Great Britain and Germany—bringing France some 20-billion francs ($57-million) a year in foreign exchange.

American Metal Joins Montgary

STOCK HOLDERS of Montgary Explorations Ltd., Toronto, ratified an option agreement in late May whereby American Metal Co. Ltd. obtains a 60% interest in Montgary's lithium mine at Bernic Lake, Manitoba. (*E&MJ*, May 1957, p 198)

Option gives American Metal, which has been drilling the orebody at the site for several months, the right to examine the orebody and the option to participate in the development of the mine, flotation concentrator and marketing of spodumene concentrates.

More than 27,000 ft of diamond drilling by the two firms have reportedly indicated a spodumene orebody of more than 8-million tons averaging 1.85% Li_2O. Montgary says that recent tests show feasibility of producing both ceramic grade and chemical grade concentrates by magnetic separation following flotation. Based on assumed mill feed assay of 1.85% the yield of ceramic grade concentrate assaying 5.3%. according to the company, would be 21.3% of the weight of the ore, and in addition, 11.4% would be in chemical grade concentrate assaying 5.3%.

If American Metal exercises its option by Nov. 1 of this year, a new company will be formed 60-40% American Metal and Montgary. Development of the mine by Montgary is proceeding pending American Metal's decision. Electric power has been available at the mine since March, buildings and head frame are up. A 3-compartment shaft is now well below 100 ft and is expected to bottom out in the upper orebody at 350 ft sometime this month. Final depth will be 650 ft.

Currently-planned flowsheet for the ore for Bernic Lake involves grinding the ore to minus 65 mesh and conditioning with various reagents, followed by flotation, making a spodumene rougher concentrate which would be cleaned once.

A secondary flotation concentrate would be made from the cleaner tailing and added to the main concentrate.

The combined concentrate would be subjected to magnetic separation to produce a ceramic grade concentrate containing about 0.2% Fe_2O_3 and a chemical grade concentrate containing 0.8% Fe_2O_3.

Tailing from the lithium flotation would be floated to remove mica and would then be conditioned with further reagents, followed by flotation to recover a feldspar concentrate, the feldspar tailing being the quartz concentrate. Feldspar and quartz concentrates would then be treated by magnetic separation to reduce the iron to the desired limits of 0.07% and 0.03% Fe_2O_3 respectively.

Independent investigation of a new chemical treatment process of the flotation concentrates by Montgary to produce lithium chemicals is being continued. More than $20,000 has been spent by Montgary in pilot plant tests of the new process.

AEC Seeks Engineers

PERSONNEL SPECIALIST Emil D. Ericson, AEC Grand Junction office is seeking applications from graduate engineers to participate in the concentrate procurement program. Additional personnel are required, Ericson notes, to assist in administration of procurement contracts with private producers. His announcement follows:

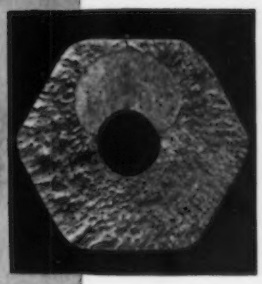
"Graduate engineers with a minimum of four years' experience in design, construction, or operation of ore beneficiation or hydrometallurgical plants. Duties involve administration of mill contracts throughout Western United States. Annual salary range $7,035 to $10,065 dependent upon qualifications and experience. Submit resumé of education, experience, and personal history to Personnel Office, U. S. Atomic Energy Commission, Grand Junction Operations Office, Grand Junction, Colorado."

South African Group Forms

A NEW SOUTH AFRICAN mining group, consisting of Engelhard Industries, Anglo American Corp., Union Corp. Ltd., and a group of bankers comprising N. M. Rothschild and Sons, J. Henry Schroder & Co. Ltd., and Robert Benson Lonsdale & Co. Ltd., has taken control of Central Mining and Investment Corp. The new company will incorporate in South Africa.

DSS 75A

SR—the new Sandvik Coromant treatment gives steels 50% longer life

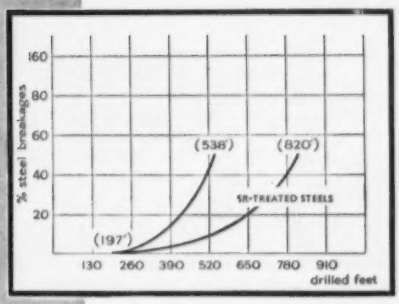


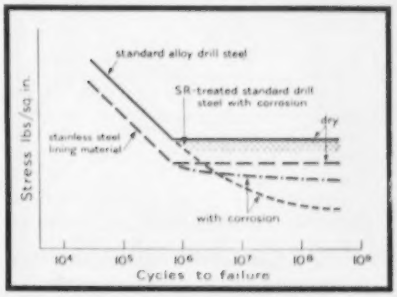
Corrosion invariably lessens the fatigue strength of drill steels and causes earlier breakages. The breakages start from corrosion craters and indentations, around which ever-widening areas of worn surfaces are formed. (See picture of cross-section.)

The main cause of corrosion is moisture—so effective protection of the steels against moisture during both storage and actual drilling eliminates corrosion and gives longer life to the steel. This protection is given to Coromant integral steels by the SR treatment, a new exclusive Sandvik feature.

PRACTICAL TESTS GIVE CONCLUSIVE PROOF

The diagram on the left shows clearly that SR-treated steel rods have a 30%-50% longer working life than those of untreated steels. Figures are based on extensive practical tests, which resulted in an average drilling depth of 820 ft. for SR-treated steels as against 530 ft. for untreated steels, before rod breakage.





HOW SR TREATMENT PREVENTS CORROSION

SR treatment is a new method of surface protection developed by Sandvik. It protects both the wall of the flushing hole and the outer walls from corrosion by a thin but strongly adhesive layer. The fatigue properties of the steels therefore correspond to those valid under dry conditions. On the wall of the centre hole, usually subjected to water flushing, the SR layer is everlasting, and *does not decrease the diameter of the flushing hole*. This is a distinct improvement on the old means of coating the centre hole with stainless steel, which lessens the diameter of the flushing hole, prevents full and effective flushing, and thus diminishes the drilling rate. Moreover, stainless steel has a lower fatigue strength than standard alloy drill steel.

Sandvik Coromant drill steels have been closely developed together with Atlas Copco rock drills. This drilling combination has for years been the most widely used in the world.

Sandvik Coromant integral steels, extension steels and detachable bits are supplied by Atlas Copco, who, in their own field, are the world's largest manufacturers of rock drills. For further information please contact: **U.S.**—Atlas Copco Pacific, Inc., 930 Brittan Avenue, San Carlos, California, Atlas Copco Eastern Inc., P.O. Box 2568, Paterson 25, N.J. **CANADA**—Atlas Copco Canada Limited, Montreal Airport, P.Q. **MEXICO**—Atlas Copco Mexicana S.A., Apartado Postal 56, Torreon, Coahuila.

Atlas Copco

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment

TUNNEL CREWMEN install ties under track in the new 5490 ore haulage tunnel at Bingham Canyon which Utah Construction Co. is driving. Completion is not due for more than two years.

Ore Haulage Tunnel Will Carry Bingham Ore 18,000 Feet

UTAH CONSTRUCTION CO. has driven over1715 ft through heavy ground on its $12-million ore haulage contract with the Utah Copper Division of Kennecott Copper Corp.

The 18,000-ft tunnel, when completed "a few years hence," will serve as the 5490-ft level ore haulage for the huge Bingham open pit copper mine.

Heavy ground encountered in recent weeks has slowed progress in what will be the longest ore-haulage tunnel project in U. S. mining history. Utah Construction plans stepping up the pace of operations.

Tunnel is being driven with a bore 21 ft wide and 25 ft high. In rough ground, 10-in. steel ribs are employed and 6-in. steel elsewhere. A 10-in. concrete lining will be poured throughout.

On completion, service from the pit will be by single-track, standard gage rail with operations under centralized traffic control.

Australia Plans Power Project

AUSTRALIA'S HOPES for a future as a major producer of import minerals received a major boost last month with announcement that vast bauxite deposits have been discovered in the Cape York peninsula, northeastern corner of the continent.

Discussions of plans for utilization of the mineral have included (1) survey of hydroelectric resources in Papua, (2) similar studies in New Guinea, and (3) construction of an atomic reactor to supply electric power for reduction plants.

Consolidated Zinc Corp. Ltd.'s subsidiary, Consolidated Zinc Pty. Ltd. conducted tests on the Cape York deposits for more than a year and, according to *The Times* of London, established "at least two 100-square mile deposits." Early plans foresee annual output of 1-million tons from the property.

Australian federal authorities are reported to be selling the government share of New Guinea Resources Prospecting Co., where their partner is British Aluminum Co. Ltd., to Consolidated Zinc. The new company will survey hydroelectric resources in Papua.

If further surveys confirm present expectations, local authorities estimate that as much as $1-billion might be spent to establish an aluminum industry. Surveys so far completed have established water resources and other relevant conditions in Papua adequate for a hydroelectric project.

Other bauxite deposits are known in Arnhem Land, Northern Territory.

Local Australian authorities note that an atomic power station in the Cape York area could also supply power for production of alumina and aluminum.

One condition of further development of aluminum in Australia will be, according to local authorities, that the government industry in Tasmania be provided with all needed quantities of alumina and bauxite at satisfactory prices. That industry will continue to supply domestic requirements of the nation, while the new project would bring in export revenue.

At least one international mining company has also made some plans to import Australian bauxite or alumina to the Western Hemisphere for reduction to aluminum.

Bancroft Area Notes Faraday Mines Opening

THE LARGEST of Bancroft area's uranium mines, Faraday Uranium Mines, was officially opened in late May by Premier Leslie Frost of Ontario. Milling at the 1,000-tpd plant in the district north of Toronto actually started April 4, operating under a $29-million contract with Eldorado Mining & Refining Ltd.

Faraday will also process ores from Grayhawk Uranium mines, a Bancroft neighbor, until the latter completes its $17.8-million contract with Eldorado.

Decision on Uranium in Lignites Due Shortly

CLAIM HOLDERS in the lignite country of Montana and North and South Dakota can not know if their claims have any value or not until present studies on separation are finished, Jesse C. Johnson, director of raw materials, AEC, told Congress. Testifying in support of a bill to defer for one year (until July 1, 1958) completion of the $100 annual assessment work required by law to be done on each mining claim, Johnson said it should be known within a year, and possibly within the next few months, whether uranium can be economically extracted from the lignites.

He noted that reserves in the Montana-Dakotas area are estimated at between 500,000 and 700,000 tons. Two firms engaged in research, Johnson said, hope to come up with an answer soon. One firm has spent "well over a million dollars" and has indicated to AEC that an answer might be due by July 1. Another firm expects to decide within a few months.

Argentina Frees Import Of Mining Machinery

MINING MACHINERY may now be imported into Argentina without surcharge, under terms of a new regulation announced recently by the Treasury Minister, Adalberto Krieger Vasena.

The purpose of this move, according to the minister, is to allow those segments of Argentine industry whose products now have to be imported, or whose products may be exported in quantity, to re-equip themselves through use of foreign credit.

$40-Million Titanium Project Locates in N.C.

LOCATION by Allied Kennecott Titanium Corp. of a multi-million dollar plant at Wilmington, N. C., is expected to start a search for a commercial grade of ilmenite ore in the state.

Although the plant, plans for which have just been announced, expects to start operations with the use of slag from Quebec Iron and Titanium Co. of Que-

Out where performance alone is not enough!

Near Butte, Montana, a CAT* DW20 Tractor works on a haul road at an open-pit copper mining operation. The road, half a mile long and 60 feet wide, had to go in fast. So a pair of DW20s with Scrapers dumped some 1600 cu. yd. of dirt per 8-hour day, and did it day in, day out till the job was done.

And that's the point: *day in, day out* till the job is done. For, on the hard jobs, performance alone, while mighty important, is not enough.

Sure, DW20 units give superior performance. Big capacity. Load easily. Big rimpulls that overcome grade and rolling resistance on rough roads. Ejection that gets rid of any kind of material quick. And, of course, high speed.

But the DW20 does more than a good job. It *stays* on that job. It shrugs off the down time that hurts you in your cost-per-yard figure. Your Caterpillar Dealer is ready with facts and figures to prove that the built-in durability of the DW20 means dollars and cents to you. He's ready, too, with expert service—and with replacement parts you *know* you can trust.

P.S.: Your Caterpillar Dealer will demonstrate the DW20 on your job, at your say-so—with any of its famous running mates: the new No. 456 Scraper with LOWBOWL design; the Athey PH20 Wagon specifically designed as an economical coal hauler (56 cu. yd. heaped load); and the Athey PD20 side dump Wagon with a heaped capacity of 25 cu. yd.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

WANTED—
THE HARD WORK

This Hewitt-Robins slope conveyor takes ore from a 48" H-R dock conveyor which runs the length of the Canton Railroad ore pier in Baltimore. It carries 3,000 tons of ore per hour up a 16° slope into a weighing station for loading into railroad cars.

This continuous flow of materials cuts handling costs, speeds turn-around time for ships and shore carriers. Here, as in hundreds of industrial applications, Hewitt-Robins engineered, manufactured, and installed the complete bulk materials handling system. To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Connecticut.

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INDUSTRIAL HOSE . . . VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

Titanium (*Continued*)

bec, Canada, shipped to Wilmington by water, it is expected to seek raw materials closer at home.

Ilmenite deposits, from which titanium can be derived, occur in several parts of North Carolina, principally in Caldwell, Clay, Ashe, Guilford, Beaufort, Gates, Chowan, Perquimans and Onslow Counties. While commercial production of the mineral in the state has been limited up until now, there is a possibility that commercial grade ore in larger counties can be found.

Governor Luther H. Hodges of North Carolina said "a nearby source of titanium will be helpful in the location of other plants in the state, such as paint manufacturers and fabricating plants using titanium metals."

Raymond Kargent, vice president of Allied Kennecott and manager of the Wilmington project, said it is hoped to begin construction of the plant "in the middle of the summer," and that a labor research and development laboratory will be the first unit to be built. It will employ 100 technicians, Largent said, and when in full operation will employ 500. "We will grow as the output grows," he said. "We also have plans for expansion."

The plant will be built on a 1,500-acre tract on the Cape Fear River, two miles below Wilmington and will represent an initial investment of $40-million with one half being provided by Allied Chemical and Dye Corp. and the other half by the Kennecott Copper Corp. Not all of the funds will go into the plant itself, however, Largent said, as funds will be necessary for working capital and inventory.

Reading Tube Schedules Copper Refinery in East

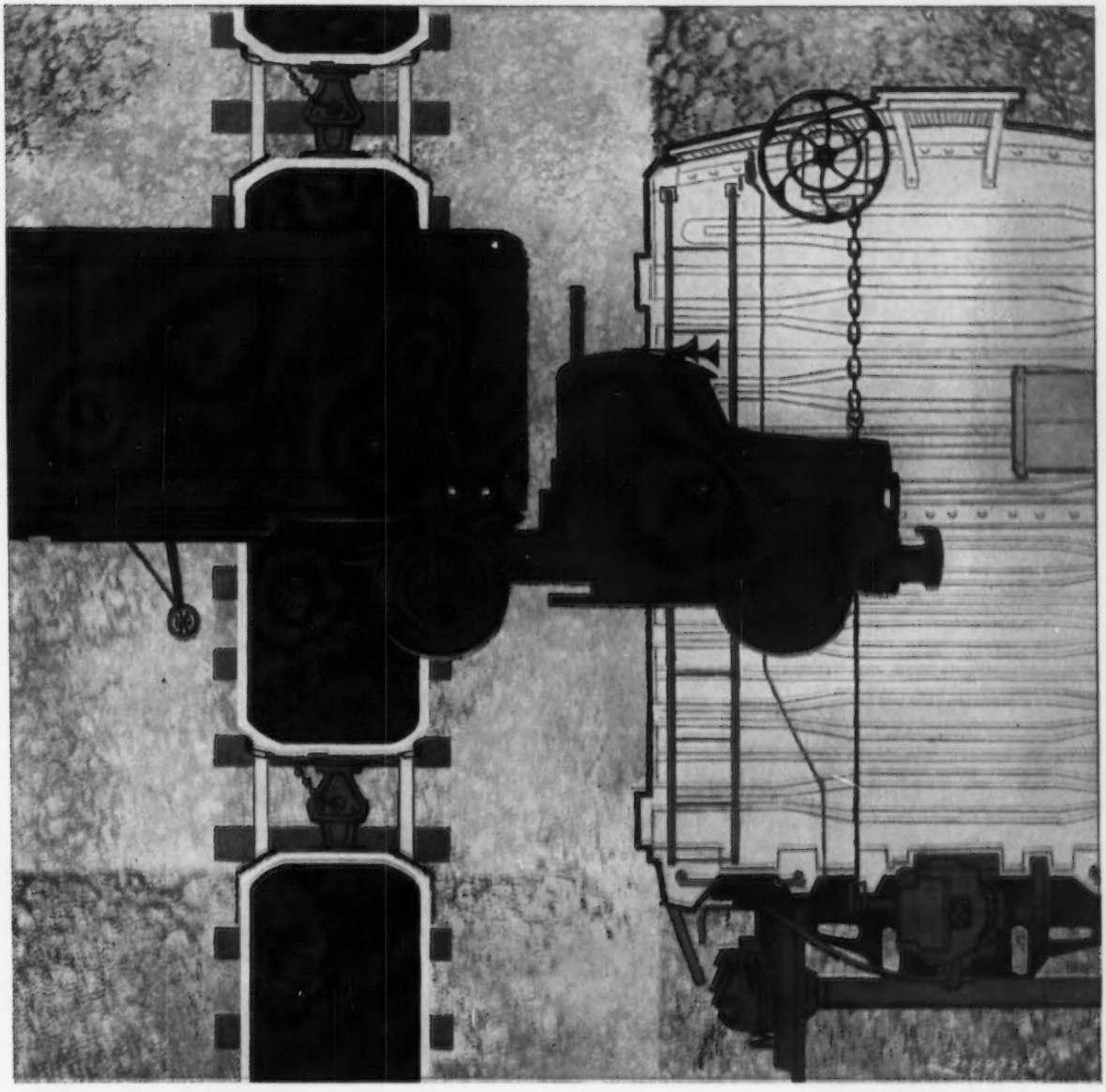
ELECTROLYTIC COPPER will be produced from scrap or blister copper at a new $4-million refinery to be constructed in Ontelaunee Township, Pa., by Reading Metals Refining Corp.

The new firm, a subsidiary of Reading Tube Corp., expects to begin production this summer. Martin Mack, president of the parent company, noted that the facility will produce some 1,200 tons per month. He noted that it was the first copper refinery to be built in the eastern U. S. in 55 years.

Idaho Firm Schedules New Mercury Process

HOLLY MINERALS, of Cinebar, Wash., will begin production of mercury in a new plant that is the result of a research project at Washington State College. The WSC division of industrial research recently completed the project, which involved concentration, leaching and electrolytic deposition of mercury from central Idaho ores.

The Holly mercury mine in the past has treated ore by the retort method, but high arsenic content in the lower grade ore now being mined made treatment difficult and created a health hazard.



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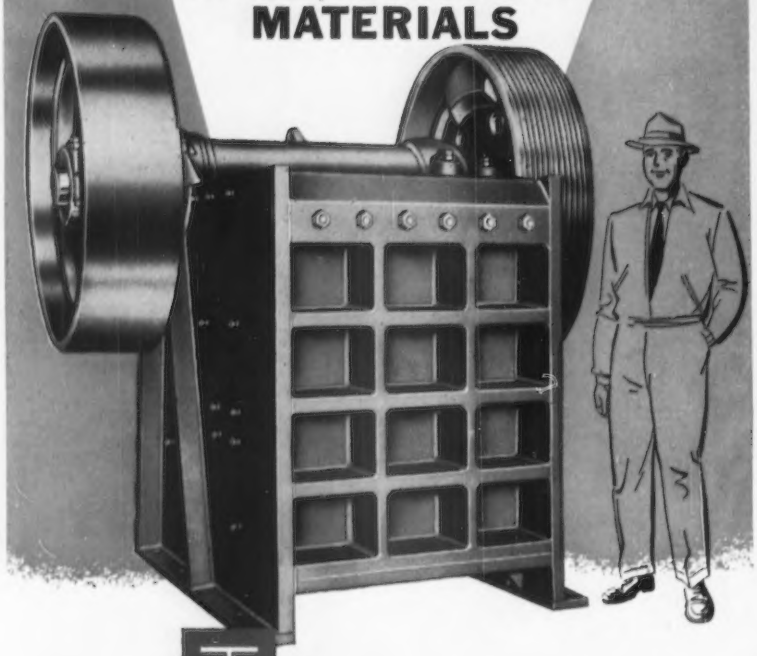

NEW McLANAHAN JAWMASTER CRUSHERS

With force-feed action and long jaw design, these high-capacity, all steel Jawmasters feature roller bearings throughout. There are thirteen models—ranging from 10 x 16 to 40 x 48, with capacities up to 750 tons per hour.

Write for Bulletin JM-56.

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McLANAHAN

Mercury (*Continued*)

Professor Ernest Oberbillig of the University of Idaho performed small scale tests on the ore previously, using the Thornhill process developed in New Zealand. The new process showed promise and WSC's mining experiment station started large scale pilot plant tests. The method was proven feasible and the company is planning to start construction soon of a plant to turn out some 1400 lb of mercury a day.

Three Schools Plan For Rock Study Symposia

THREE MINING SCHOOL have completed plans for joint sponsorship of symposia in the fields of rock mechanics, drilling and blasting and exploration drilling.

At present, the University of Minnesota, Pennsylvania State University and Colorado School of Mines each sponsor a symposium. It is now planned that all symposia will rotate among the three schools and that each symposium will be held ever other year, bringing better geographical representation, both in papers and attendance.

Under the tentative schedule, drilling and blasting symposia would be held at Minnesota in 1958, Colorado in 1960 and Penn State in 1962; exploration drilling at Penn in 1959, Minnesota in 1961 and Colorado in '63. Rock mechanics sessions would be held at Colorado in '59, Penn in '61 and Minnesota in '63.

QMI Joins Group to Mine New Caledonia Laterites

QUEBEC METALLUGGICAL INDUSTRIES LTD. has acquired 45% interest in a company to be formed with French interests to acquire and mine laterite deposits on the French island of New Caledonia.

Partners in the venture are Le Bureau de la France d'outre-Mer, L'Union Europeene Industrielle et Financiere, and La Societe d'electro-Metallurgie et des Acieries Electriques d'Ugine. Latter two firms are involved in ore buying and metallurgy, respectively. Technical management will be by QMI.

Ownership of properties containing nickel and cobalt is being negotiated.

Beryllium Corp. Start

NEXT MONTH is expected to see the start-up of production at Beryllium Corp.'s $300,000 plant at Hazelton, Pa. for production of pure beryllium billets for a $23.5-million contract with the AEC. Walter R. Lowry, president of the firm, noted that full production will not begin for some time. Contract calls for 500,000 lb of billets over a 5-year period.

Plant Uses Sill Process

THE FIRST large-scale test of the Sill process of alkaline leach and hydrometallurgical separation from ores with high contents of arsenic and sulphur is scheduled this month at Newburgh, N.Y.

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Sill Process *(Continued)*

by Metallurgical Resources, Inc.

Advantages, according to company announcement, are high recovery at lower cost, 98% purity of product and elimination of arsenical-sulphuric fumes.

Initial production will be on cobalt, though firm says process is also applicable to nickel, copper, silver, iron, lithium and tungsten ores.

IN THE U. S.

ALASKA

Estimated production at the Red Devil mine at Sleitmute this year will make the Alaskan enterprise the largest single domestic producer of mercury, according to John Murphy, manager. Murphy believes his company is a forerunner of a large mercury producing region which will be centered in the Kuskokwim River basin.

Estimated production during 1957 at the mine has been set at 6,000 flasks totaling a present monetary value of about $1.5-million. This will be roughly one-third of the total U. S. production.

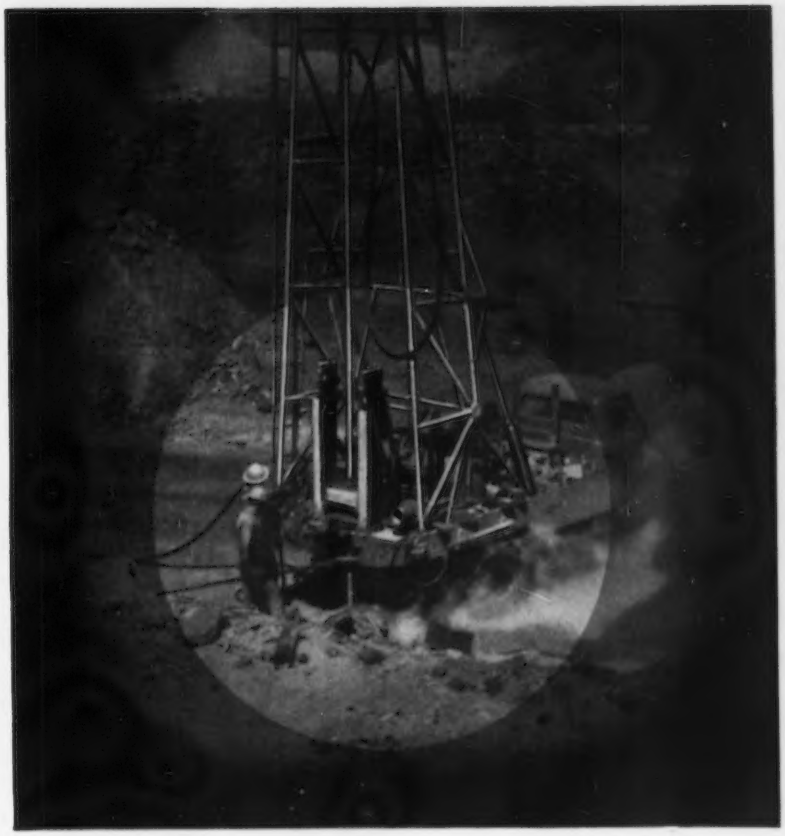
Kennecott Copper Corp. has established a continuing $1,000 scholarship in mining engineering at the University of Alaska effective with the fall 1957-58 term, according to Dr. Ernest N. Patty, university president. The firm will also provide an additional $1,000 to the school.

The House territories subcommittee has approved a bill to open a 320-acre tract near Klukwan to mining. It acted after hearing Phil Holdsworth, territorial mining commissioner, describe the area as having the capability of "100 years operation with a daily production of 5,000 tons of iron concentrate."

Under the bill, the land would be made part of the Klukwan Indian village subject to lease for mining purposes. Delegate Bartlett (D-Alaska) said he had introduced the bill at the request of the Klukwan village council which is desirous of obtaining employment for the Indians as well as mineral royalties.

Production of chromite ore at Red Mountain near Seldovia will probably total 16,000 tons of high grade ore for this year and next, according to Karl Bachner, assistant manager of the Kenai Chrome Co. Bachner warned, however, that beyond that point Federal legislation will be needed to provide continued assistance for domestic producers competing with Turkey and Africa.

The chrome ore from Alaska (the Kenai operation is the only one in the Territory) goes to GSA at Everett, Wash., for distribution. The company was to start operations in mid-June this year for about a three-month season. Bachner also revealed the company is building a mill to process lower grade ore which will be operated on a year-round basis.



29
SALES AND SERVICE LOCATIONS

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Here's a drill that really gets around . . . as fast as any truck . . . yet punches down holes like the biggest heavy drills. The 225 Blastair operates on the rotary air-blast principle, (continuous pressure cutting, with a continuous blast of compressed air for cleaning) developed and proved by Joy. This faster method of blast hole drilling eliminates lost holes, and drills smooth, parallel-walled holes . . . easier and safer to load. The 225 drills dry . . . eliminates piping layouts or water haulage —operates all year 'round without worry about freezing water lines.

In quarrying, stripping, and large cut-and-fill operations, the 225 has proved to be the answer to drilling problems . . . it may be the answer to your problems. Write to ***Joy Manufacturing Company, Oil Field Drill Division, P.O. Box 35326, Airlawn Station, Dallas 35, Texas.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

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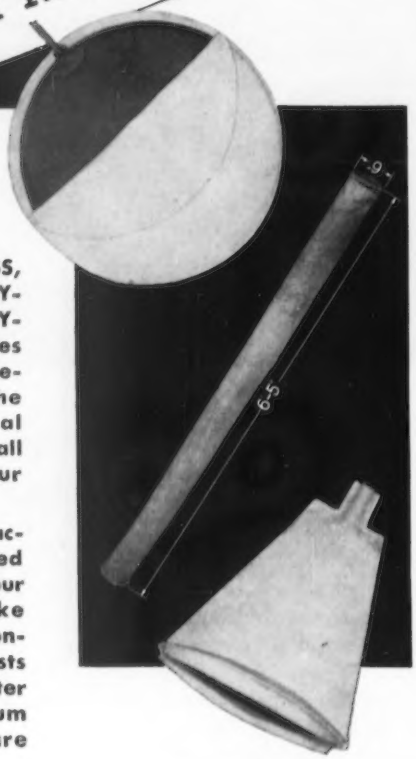

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CALIFORNIA

American Potash & Chemical Corp. is doubling production capacity of granular potash at its Trona, Calif., plant.

The project—which will cost approximately $750,000—is part of the company's current $3.5-million improvement program at the Trona plant. Installation of the new potash granulating units is being done in two parts, with the first half now nearing completion and the final half scheduled to be completed by the end of 1957.

United States Borax & Chemical Co. began open-pit mine operations at its Boron mine early in May. Tincal ore, the principal raw material for many boron chemicals, was topped at 137 ft. A total of more than 7-million tons of overburden was removed to pave the way for the open-pit operation. Company reported opening of the pit uncovered the largest known sodium borate orebody in the world. Mine is said to be the first large open-pit borate operation in the United States.

Kern Uranium Co. reported an assay of 0.43% U_3O_8 on its first shipment of uranium ore from the Little Sparkler claims in Kern Canyon, 36 miles northeast of Bakersfield. The 51-ton shipment was made last March to Vitro Uranium Co. at Salt Lake City. Ore was from trenches dug in a steeply dipping vein with average depth of the excavations being about 7 ft. Deepest penetration into the vein was 14 ft. Company presently has about 50 tons of ore stockpiled at the claims, according to Lloyd Scouler of Rio Vista, company president, and is continuing with exploratory work. Crews have sunk a 63-ft shaft offsetting the vein and are presently cross-cutting to intercept the vein. Company employs eight men in two shifts at the property. Vern Harrington of Bodfish is mine superintendent. L. F. Ivanhoe is consulting engineer and geologist.

First shipment of copper ore has been made from the Copper Lady mine in Snow Canyon, 40 miles north of Trona. Mine is owned by Mr. and Mrs. Jake Lissman of Argus. Ore is said to occur in a contract between lime and granite in the mineral form of zurite, malachite, chrysocolla and tenorite. Mine owners built a mill at the mine site to extract copper from the ore by electrolytic process to save freighting and smelting costs. Owners hope to process a minimum of 100 tons of ore a week. Preliminary assays show a probable value of between $200 and $400 per ton.

COLORADO

Cotter Corp. of Santa Fe, N. M., signed a contract with AEC May 23 for construction of a uranium processing pilot plant at Canon City.

Parker Wilson, president of Cotter, said the pilot mill will have a capacity of from 50 to 100 tpd. Colorado School of Mines Research Foundation will co-

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50,000 LB. CAPACITY FRONT AXLE

Kenworth's 803 end-dump is built big all over—from its variable section frame to its all-welded steel body. And, this is especially true of the 50,000 lb. capacity front axle. Completely Kenworth engineered and built, this front axle has an 8" heat-treated, alloy steel, I-beam center section; 3" diameter king pins with nylon bushings, and 6" diameter spindles at inner wheel bearings. Over the roughest terrain, where an ordinary heavy-duty axle would not stand the going, this one has strength to spare. That's typical of all Kenworth's spring-mounted rock and ore movers—every one built for big loads and rough roads. There's one for your job—from the 36-ton Kenworth 803, to the 18-ton 801, the 24-ton 802, the 48-ton 802-B, or the 64-ton 803-B. Ton for ton, each of these rugged rock and ore movers is engineered in every detail for greater strength, lower maintenance, longer life. Now's the time to help yourself to consistently increased profits—learn why . . .

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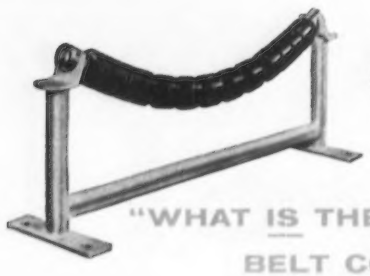

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Radically different from all other idlers, the Limberoller is a flexible steel cable suspended between two bearings . . . neoprene discs are molded to the cable . . . forming a single roll idler which turns on its own axis. This imparts a flexing action which is self-cleaning . . . prevents material buildup, a source of trouble with conventional idlers.

Supports the belt throughout its entire width . . . doesn't have the unsupported gaps left between the rolls like conventional idlers. Increases belt life 20% and more. Materials don't "bump along" from idler to idler, either.

Two bearings, instead of six. They are up out of the dirt zone, not hiding down under the belt. Joy has never replaced a single bearing due to normal failure. Heard enough? There's more . . . get the whole story from ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

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Colorado (*Continued*)

operate with the company in testing the process. Operation is scheduled to begin about Dec. 1.

The Canon City mill will be the first built to handle Front Range uranium ores, now being shipped to Vitro at Salt Lake City. The contract with AEC provides the Government will purchase concentrates for a one-year period. If the operation proves successful, Cotter hopes to negotiate for a larger mill.

A wide-open competitive market for uranium, once the atoms-for-peace program gets rolling, was predicted in Denver at a banquet of the Uranium Institute of America. David F. Shaw, assistant general manager for manufacturing of the Atomic Energy Commission, assured uranium producers tha' the Government won't use its supplies to take away their sales. By law, the Government is now the only agency that can buy uranium. But, Shaw said:

"When, as predicted by most students of world power requirements, the demand for uranium, to supply power reactors, grows to its expected proportions, we confidently believe it will provide a market for steadily increasing uranium production so that there will be real competition for it between reactors."

New mining activity is reported imminent for the area adjoining the Rifle mine of the Union Carbide Corp. about 11 miles north of Rifle. The Rifle mine, long under operation by Union Carbide and U. S. Vanadium Corp. is reported to have yielded approximately $35-million in vanadium from some 450,000 tons of uranium-vanadium ore. The mine is credited with the largest single orebody yet operated on the Colorado Plateau, it being in the form of a single sheet of ore-carrying sandstone nearly 5,000 ft long, 800 ft wide and averaging five feet in thickness.

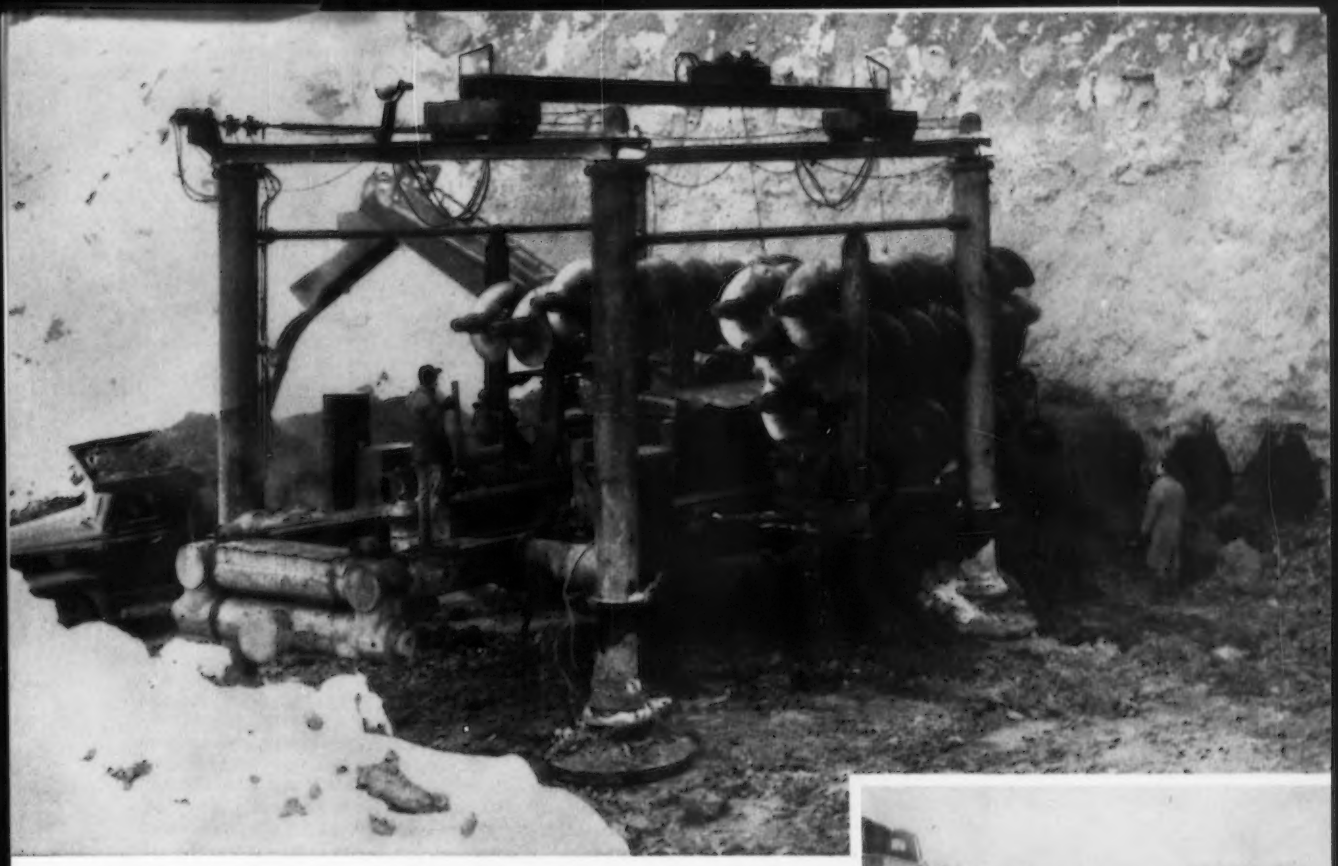
It is reported that Garfield Mines, Ltd. a Nevada corporation, has acquired 15 claims on the south side of the Rifle property and in a joint venture with Richwell Petroleums, Ltd., of Toronto, Canada, and Royal Canadian Ventures, Ltd. will start an important drilling program.

It is also reported that Kinsley Mining Corp. has acquired 34 claims on the west side of the Rifle property and that its engineers are laying out a sizeable exploration program which will soon be announced and started.

El Paso lessors Bailey and Patton at Cripple Creek have struck a sizeable orebody in a raise. Some of the samples from this ore have run over two ounces gold to the ton. Mine superitendent Earl Robush reports that he expects to have several other levels open to leasing operations within a very short time. Presently there are three sets of lessors working the mine.

Gold receipts at the Denver mint rose to 67,824 oz valued at $2,373,849 in April from 54,941 oz worth $1,922,935 in April 1956 mint officials report.

Silver receipts, however, were down to 15,230 oz worth $13,803 from 595,030



Brutal coal-boring service calls for auger blades of USS COR-TEN Steel

CRUNCHING through wet, abrasive coal and rock in sub-zero temperatures is the kind of murderous service that takes the bite out of boring equipment—but fast! In this case, however, TASA Coal Company of Pittsburgh, Pa., reduced auger wear and corrosion to a minimum, by fabricating replacement blades from 5/16-inch COR-TEN Steel.

Each section of auger is 17 feet long. The blades, or flights, are 42 inches in diameter. As each section chews into the coal vein to its full length, the chuck is opened and another section is added on. This particular coal seam near Clarksburg, W. Va., was penetrated to a depth of 200 feet.

These blades of USS COR-TEN Steel are the logical answer to the constant destructive forces of abrasion and corrosion. COR-TEN has, in addition to its high strength (50,000 psi. min. yield point) and abrasion resistance, 4 to 6 times greater resistance to atmospheric corrosion than carbon steel.

All three USS High Strength Steels—COR-TEN, MAN-TEN, and TRI-TEN "E"—enable mining equipment to give far more service per dollar of cost than structural carbon steel. They possess a 50% higher yield point, and, in varying degrees, offer greater resistance to wear, fatigue, abrasion and impact. These USS High Strength Steels are used to replace carbon steel in the vital parts of mine cars, dozers, shovels, drag lines and other such equipment to increase service life without increasing dead weight. Where the use of thinner sections is feasible, they can frequently (1) reduce equipment weight without reducing its strength, or (2) increase the size and capacity of equipment without increasing the total weight or the power needed to move it.

Want further details? Write to United States Steel, Room 2801, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

Remember that we also produce USS "T-1" Steel, a constructional alloy steel ideally suited for mining and materials handling equipment. Write for our booklet, "T-1."

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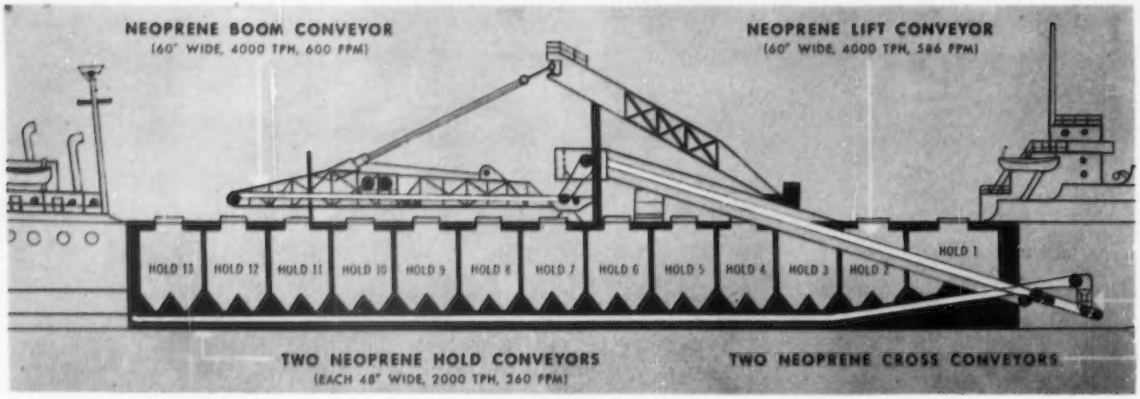
UNITED STATES STEEL



FAST MOVING CONVEYORS move iron ore from 13 holds of ore carrier-oil tanker. Oil is pumped into same storage area.

Unique Oil Tanker Doubles in Iron Ore for Top Efficiency

SINCLAIR PETROLORE, a unique double-purpose vessel has been designed to transport iron ore and oil in alternate loads. Owned and operated by National Bulk Carriers, Inc., the ship is presently operating as an oil tanker only, but as soon as ore loading facilities are completed in Venezuela she will take up the service for which she was designed.

Her circuit is: empty from Sinclair Oil Co.'s Marcus Hook, Pa. refinery to Venezuela; then through the Panama Canal to Japan with 67,000 tons of iron ore; empty to Kuwait in the Persian Gulf; around Africa and back to Pennsylvania with 400,000 bbl of crude oil. The ship is too large for the Suez Canal and therefore must go around the Cape. She will take three months for a round trip and, her owners point out, be carrying payload 91% of the time.

Ore is carried in 13 hopper bottom holds and can be unloaded by a built-in conveyor system at the rate of 4,000 tons an hour. In unloading, ore falls through discharge gates, four in the bottom of each hold, onto two 547-ft conveyors which run the length of the ship to two cross conveyors, which discharge onto a 227-ft lift conveyor that carries the ore topside to a 206-ft. boom conveyor. The boom can be rotated and elevated to pile ore 60 ft high on either side of the ship.

Oil is carried in the same holds and in surrounding hull spaces. The discharge gates in the holds are sealed tight to prevent oil from leaking into the bilge and to withstand water pressure from below in case of emergency. Her big cargo pumps can unload her at just under 30,000 bbl per hour.

Colorado *(Continued)*

oz valued at $538,529. The world price of silver continued above the fixed U. S. Government price, bringing silver to commercial outlets rather than the federal mints.

Reports are circulating in Summit County that several old silver mines are scheduled to be reopened this spring and summer. Keystone Peerless Mining already has announced its intentions of starting silver operations on Glacier Mountain. Other companies are known to have obtained options on old silver mining properties.

The Cashier property, of 11 claims, has been acquired by Gold Coin Mining & Leasing Co. of which R. B. Warren of Grand Junction, Colo. is president.

Grand Junction Operations Office of Atomic Energy Commission is selling 4½-million lb of vanadium flake (fused vanadium pentoxide) acquired over the years in connection with its uranium ore purchase program.

The flake is stored in drums in a large area in the compound. Allan Jones, manager of the center, said the metal would be sold at four-to-eight month intervals in about 500,000-lb units so as not to upset the domestic market.

AEC intends to sell the vanadium at prices which bear a relationship to present market price for carload sales, which AEC surveys indicate have been averaging about $1.22 a lb, f.o.b. Grand Junction.

First bids were to be opened July 5 at Grand Junction.

IDAHO

Nabob Silver-Lead Co. has opened the D-5 orebody in its Pine Creek property in the Coeur d'Alene District for a length of 290 ft on the new 150-ft winze level and the face of the development drift still shows 4½ ft of high-grade and about 2 ft of mining ore, company officials reported recently. Three raises on the ore have been started, but very little stoping is planned until the west limit of the orebody has been reached and a raise completed to the main adit level for ventilation purposes. On the main level, the ore zone was proved for more than 500 ft, but subsequent raising showed that it extended only about 70 ft above that horizon.

A substantial vein of good grade lead-silver ore has been found in a previously unexplored section of Day Mines' Day-rock property north of Wallace, president H. L. Day said at the annual meeting of stockholders. Vein was first disclosed by diamond drilling on the 500-ft level, he said, and a crosscut was then driven to intersect the structure. Development of the vein is now in progress, but it is expected to be some weeks before the "potentialities" of the new ore have been determined.

Pinnacle Exploration Inc. of New York, exploration subsidiary of Callahan Zinc-Lead Co. and Vulcan Silver-Lead Corp., has concluded an agreement with Uranium Mines Inc. of Wallace for exploration and development of Uranium Mines' extensive holdings in the east end of the Coeur d'Alene District. Preliminary exploration is scheduled to get underway this summer and officials said the proposed development may eventually entail an expenditure of more than $1-million.

Terms of the agreement provide that Pinnacle will advance all funds for exploration and development and will be entitled to recover its investment in full out of profits from production. Subsequent profits would be divided equally between Pinnacle and Uranium Mines. The agreement also provides that Uranium Mines will receive a minimum of $200 a month from the date of the contract, or, during the period of reimbursement, will receive a royalty of 4% on production if that amount exceeds $200.

The property covered by the agreement includes approximately 200 mining claims, embracing an area about two miles wide by six miles long, immediately adjoining on the east the Silver Mountain property which Hecla and Bunker Hill mining companies are currently exploring at a depth of 2,000 ft under a profit-sharing agreement with Silver Mountain Lead Mines Co.

Stockholders of Idaho Custer Silver-Lead Mines Inc. have approved and ratified an operating agreement with Hecla Min-

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Idaho (*Continued*)

ing Co. for exploration and development of Idaho Custer's Livingston Mine in the Boulder District of Custer County.

Agreement provides that Hecla will direct and supervise the development program outlined in Idaho Custer's contract with the DMA, which includes deepening the present shaft 250 ft and completing some 800 ft of tunnel work and 2300 ft of diamond drilling on the 2500- and the new 2750-ft levels. Idaho Custer will finance the program, estimated at $120,000.

Funds for any additional development will be advanced by Hecla, with 40% chargeable to Idaho Custer but recoverable only out of Idaho Custer's share of future profits. If ore is discovered, Hecla will be entitled to a 60% share, but must pay the first $120,000 of its share of the profits to Idaho Custer for a 60% interest in the Livingston property, mill and surface plant. Subsequent profits would be divided 60-40.

Hecla had planned to start operations at the property as soon as road and snow conditions permitted. The mine is at an elevation between 9- and 10,000 ft.

An offer by Abot Mining Co. of Wallace to purchase the properties of Hunter Silver-Lead Mines Inc. and Pilot Silver-Lead Mines Inc. in the Hunter District northeast of Mullan have been approved by stockholders of both companies. Hunter Silver-Lead will receive 1,667,000 shares of Abot capital stock for its claims and lease rights adjoining Day Mines' Gold Hunter property, and the Pilot firm will receive 1.3-million Abot shares for its holdings, including the Cincinnati lease, in the same area.

The Abot company, which is headed by H. L. Day, president of Day Mines Inc., will consolidate the two properties, along with other Day and Hecla Mining company holdings in the area, into a single property for deep exploration from the Gold Hunter shaft which Day Mines has rehabilitated to a depth of 1200 ft. Some 40 patented and unpatented claims are involved in the consolidation.

An exploration program is expected to be started this summer.

General Mines Corp. has reopened the underground workings at its property on Little Pine Creek southwest of Kellogg to permit inspection by "a major mining company" president H. G. Loop reported recently. A substantial cave at the main portal had to be cleared and about 90 ft of ground had to be retimbered to make the workings accessible, he said.

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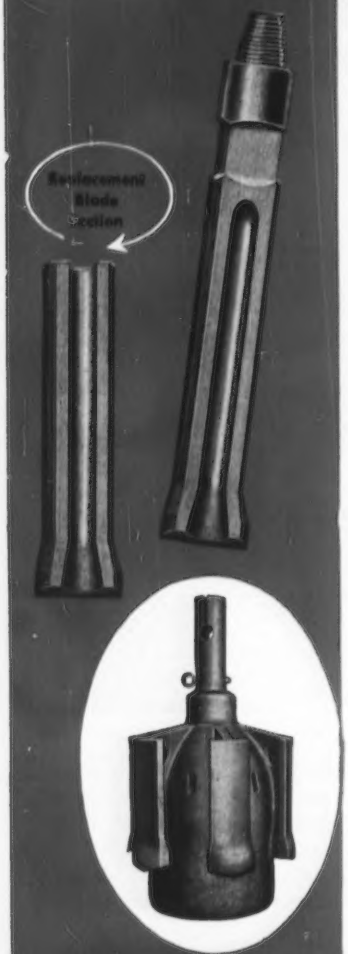

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Stauffer Chemical Cites New Phosphate Discovery

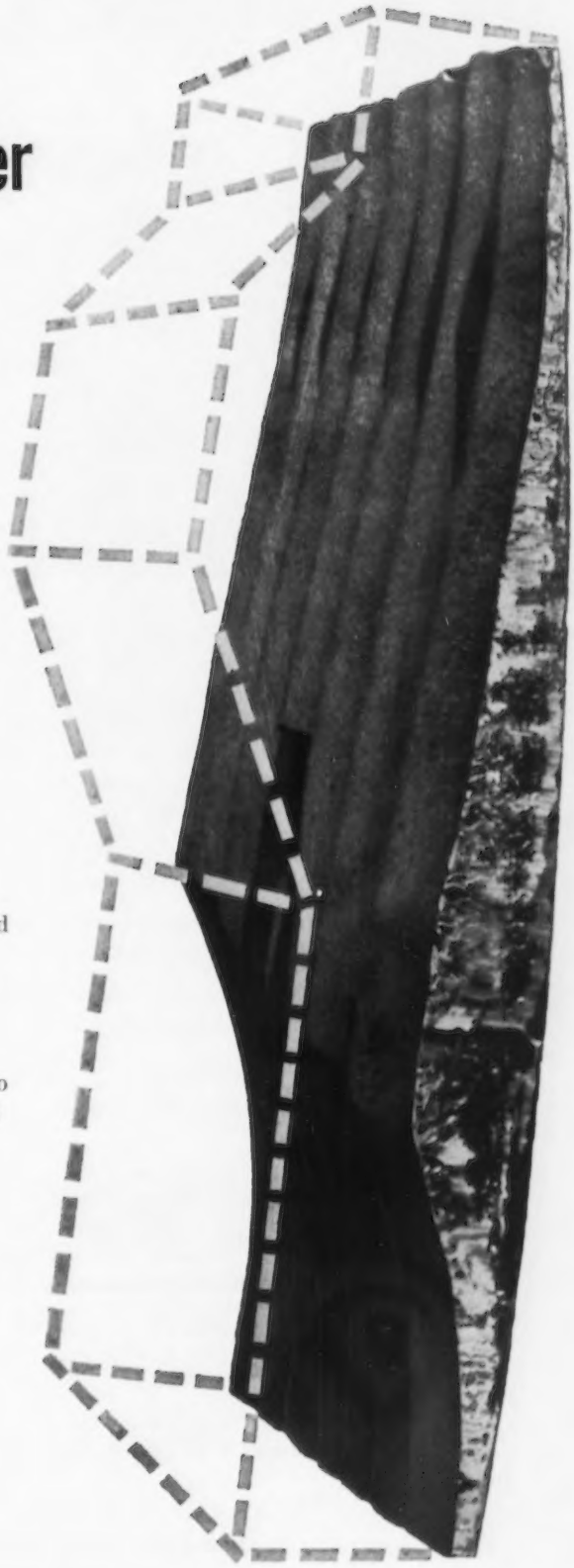
INDICATIONS of "a multi-million ton" orebody has been announced by Stauffer Chemical Co. at the company's Hot Springs, Idaho phosphate rock property. Company has been conducting extensive underground work for the past three years and has located "at least a million tons of easily minable, high grade phosphate rock for manufacture of superphosphates." In addition, company says, "many times that tonnage of high grade rock is indicated, and a vast quantity of lower grade phosphate shales has been proven out."

The latter, company says, could be used as raw material for the electric furnace production of elemental phosphorous or might be beneficated. Firm points out that current reserve picture is such that low grade need not be mined immediately.

Bunker Hill Co., on May 1, put into full operation a new fifth unit at its electrolytic zinc plant near Kellogg, increasing production capacity by 25%. The new installation is part of the $15-million expansion program which the company has scheduled over the next five years.

Another plant improvement now under construction is a five-mile pipeline to bring a supplementary supply of industrial water for the zinc plant, lead smelter and concentrator from wells on the bank of the North Fork of the Coeur d'Alene River near Enaville. The 24-in. pipeline will deliver 3,900 gpm with one pump in operation and 5,650 gpm with two pumps running. A 600,000-gal storage surge tank is being constructed at

Ni-Hard ball mill liner grinds 600,000 tons of ore in 711 days



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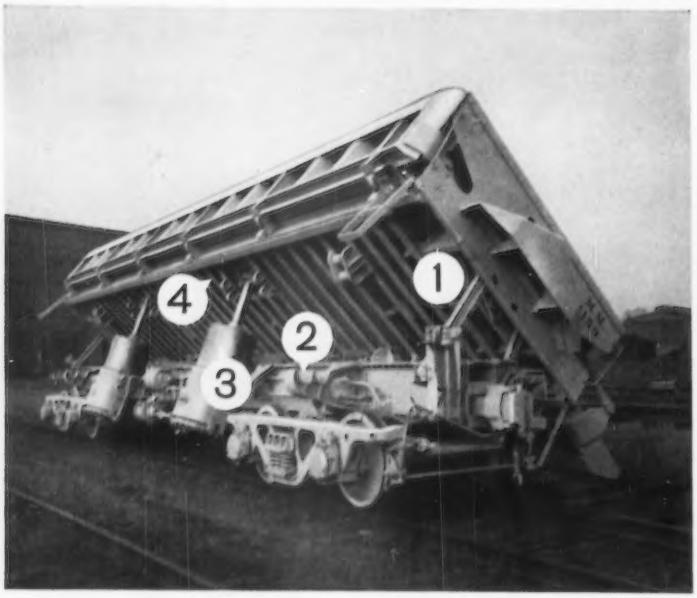

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Idaho (*Continued*)

the mouth of Silver King gulch to handle the supplementary supply. Water supply at the company plants has been critical in the late summer months in recent years and the expansion program is expected to aggravate this situation.

American Smelting and Refining Co.'s big Morning mill at Mullan—one of the most famous land-marks in the Coeur d'Alene district—was destroyed by an early-morning fire on May 21. The mill building and all the equipment, and some associated structures, including the laboratory and sample house, were almost completely consumed by the blaze which raged for nearly four hours, resulting in a loss estimated at between $400,000 and $500,000.

Adjacent surface buildings, including the head house and rope house near the mine portal above the mill, and the machine shop, electrical shop, sawmill and carpenter shop and the main office and warehouse were saved.

Production at the mine has been suspended pending a decision on whether or not a new concentrator will be erected at the mine. Consideration is also being given to offers by other companies to treat the Morning output on a custom basis. Meanwhile development work has been resumed and about half of the 180 men idled by the fire have been put back to work.

The mill had a rated capacity of 1,000 tpd, but since the closure of the lower mine workings in 1953 had been operating on a reduced basis—from 200 to 250 tpd.

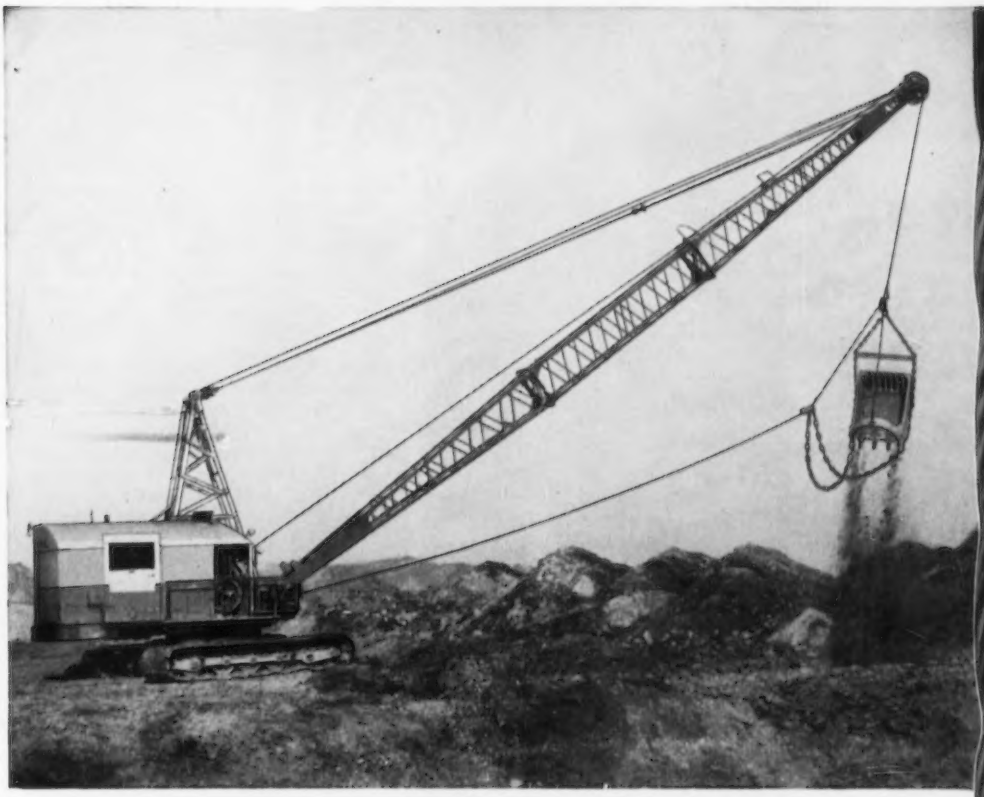
The Morning mill was built before the turn of the century to replace a previous plant which was destroyed by fire in 1898. It had since been expanded and modernized to one of the largest concentrator plants in the district.

Sidney Mining Co. has joined with Mascot Mines Inc. in another uranium venture on the 36-claim Rocky group adjoining Sunshine Mining Co.'s Ranson Mine in San Juan County, Utah, near Blanding. The claims have been purchased outright, subject only to a royalty of 10%, and a geophysical survey is now in progress that has already indicated the presence of "one or more major orebodies" on the property, officials said.

Exploration and development is still underway at the other Sidney-Mascot joint venture, on the Colorado River property in San Juan County, and some ore has been shipped, but so far the orebodies have been too narrow for profitable operation.

At Sidney's zinc-lead operation in the Coeur d'Alene District a new segment of ore about 125 ft long has been found on the 1300 level beneath the East ore shoot, and an "interesting" stringer zone with some zinc-lead values has been opened in the west drift on the 2300 level. The east drift on this level has been advanced nearly 500 ft into adjoining Nevada-Stewart ground and is within 350 ft of its intital objective.

Sunshine Mining Co. has opened ore in two development headings on the bot-



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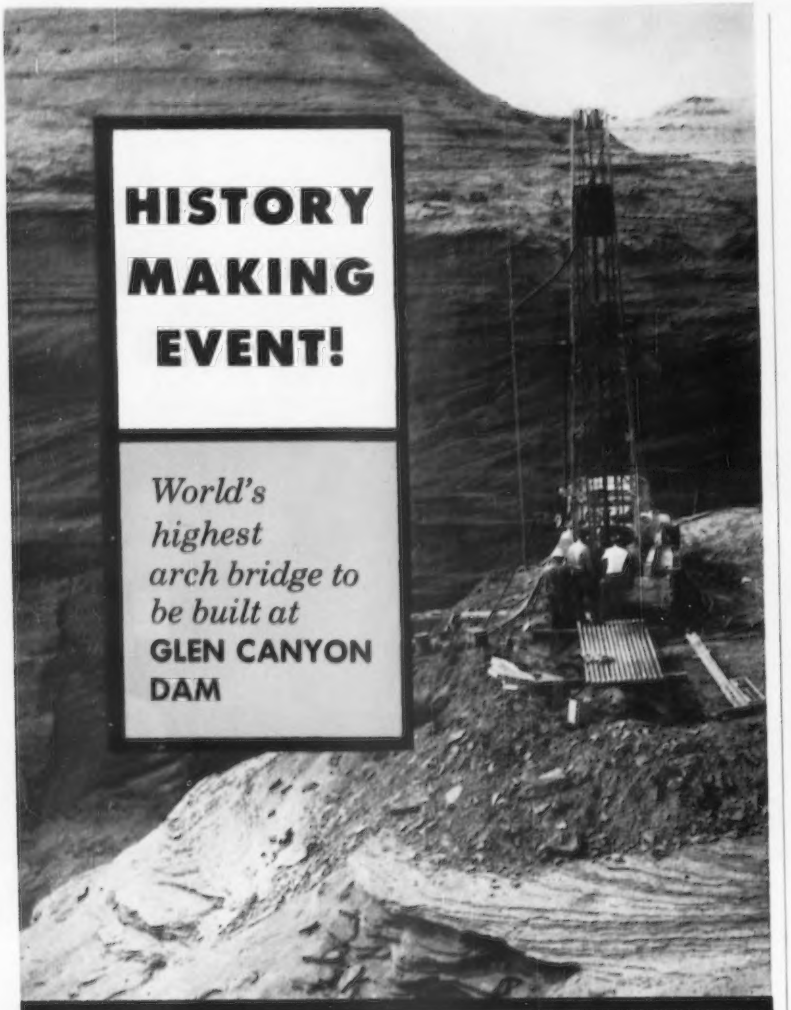

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Idaho *(Continued)*

tom 4,000-ft level of its big silver mine in the silver belt of the Coeur d'Alene District between Wallace and Kellogg. A crosscut from the main Jewell shaft in the western part of the workings has exposed a one-foot width of good-grade silver-lead ore in the West Rambo area of the Silver Syndicate vein, and a drift off the No. 5 shaft workings in the easterly portion of the property has reached the downward projection of the main Chester ore shoot in the Rotbart area.

Idaho Goldfields Inc. has resumed operations at its lead-silver-gold property near Fourth of July canyon between Kellogg and Coeur d'Alene and will start production of lead carbonate ore as soon as the 168-ft incline shaft has been unwatered. Two shipments of concentrates were made from the property last fall and the small mill has since been improved by the addition of finer grinding equipment.

Bradley Mining Co. has laid off approximately half of its 100-man crew at the Ima tungsten mine in Lemhi County near Patterson. Curtailment of the tungsten purchase program was reported to be responsible for the move.

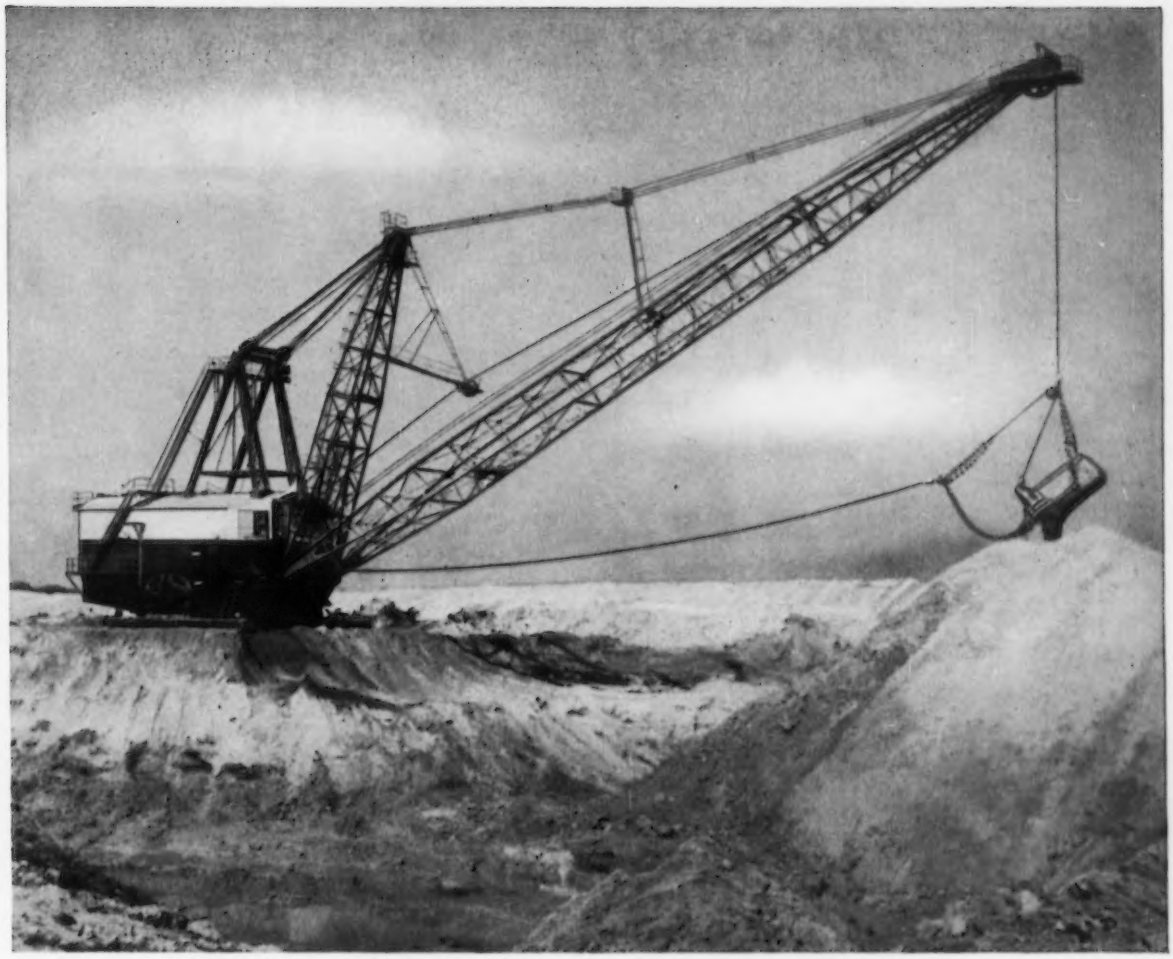
Silver Star-Queens Mines Inc., now the second largest ore producer in Blaine County, shipped 3,414 tons of crude ore with a gross value of $163,000 during the year ended March 31, and is continuing production at a rate that promises to put the property on a profitable basis if development results continue satisfactory. Present production is from stopes above the 600 level on the Queen-of-the-Hills vein, and meanwhile the winze is being extended to the 900 level under a DMEA contract. Roy T. Fitz is general manager of the operation and Garfield Voget of Hubbard, Ore., is company president.

Lucky Friday Silver-Lead Mines Co Wallace, reported 1956 net income of $511,298. Ore production for the 11 months prior to April 1 totaled 40,212 tons. President Charles E. Horning said shipments this year have totaled 55 cars of lead-silver concentrates netting an average of $14,000 a car and two cars of zinc concentrates.

Development work during the past year, officials said, included shaft deepening, station and pump room excavation, 1,000 ft of drifting, 660 ft of crosscutting and 370 ft of raises. Company expected to complete shaft extension to a depth of 3130 ft last month.

ILLINOIS-KENTUCKY

J. Willis Crider, fluorspar operator of Marion, Ky., has leased the Pigmy mine in Crittenden County from the Rosiclare Lead and Fluorspar Mining Co., and started production. The mine, a steady producer of metallurgical grade for many years, had been shut down for the last 5 years, but was pumped out and re-



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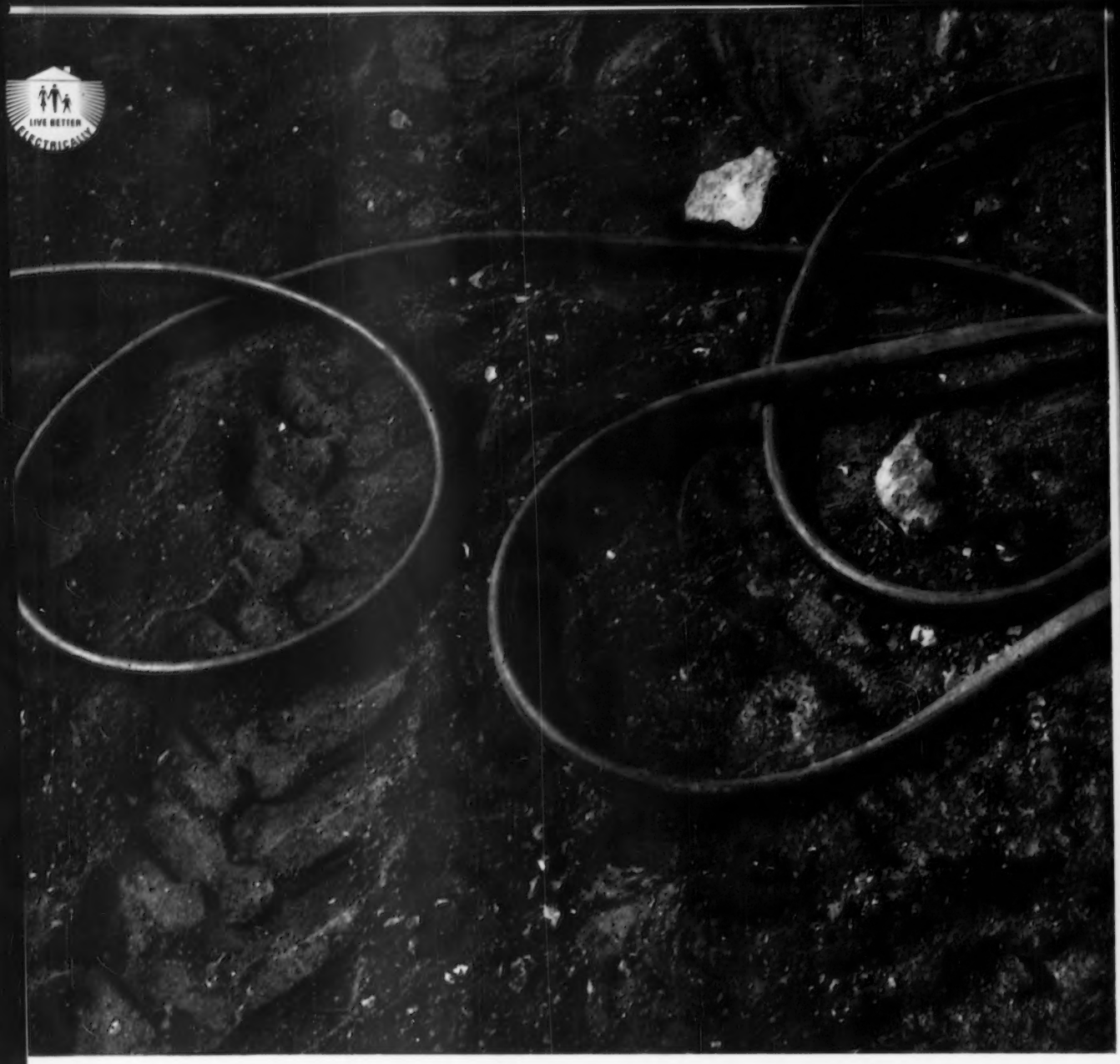

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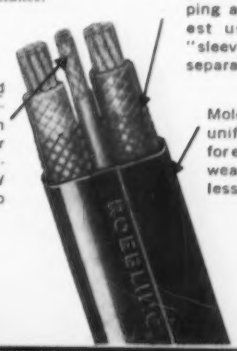

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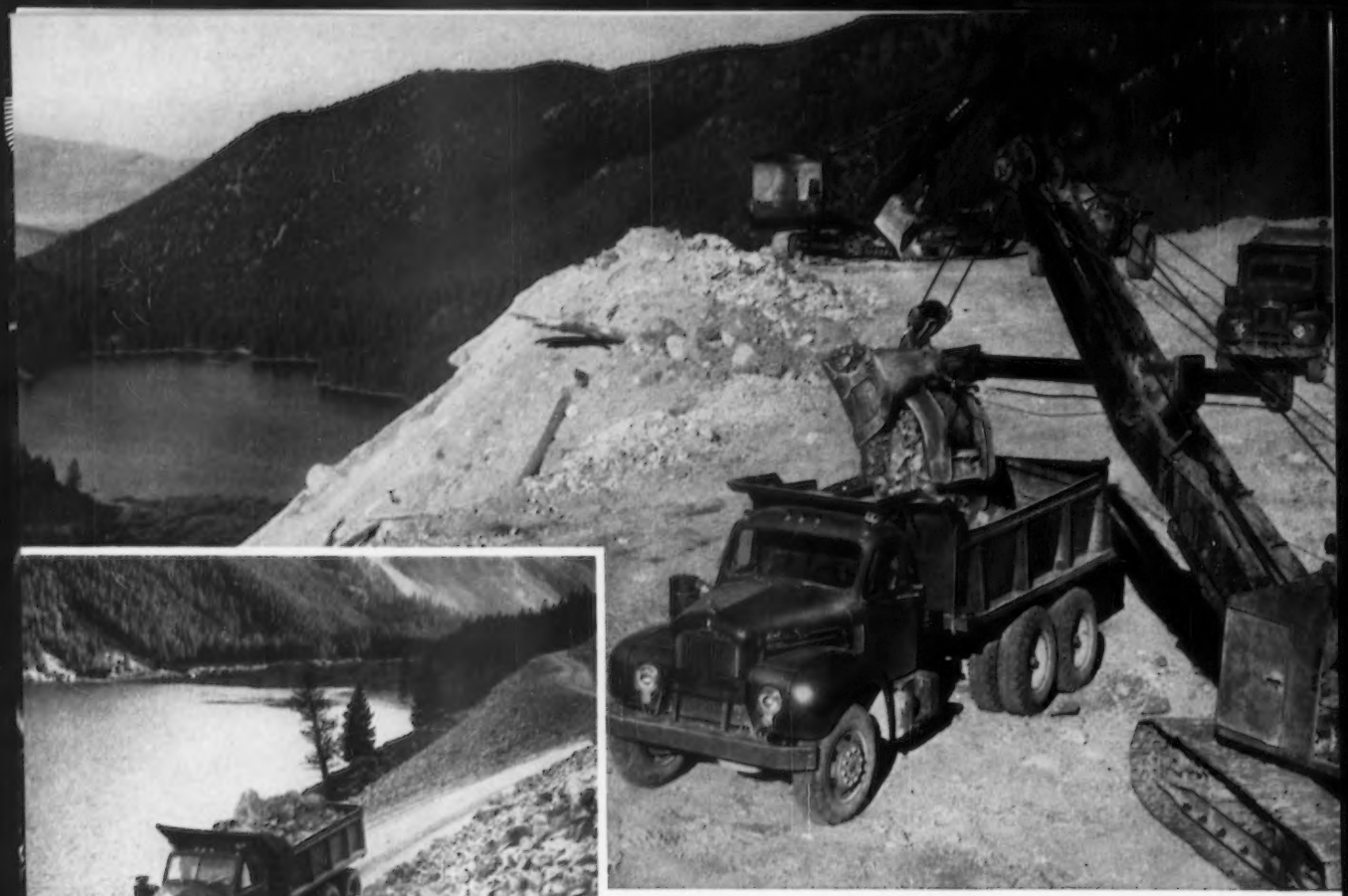

Loading tungsten ore near Glen, Montana, at the Ivanhoe Mine of Minerals Engineering Company.

(Left) Winding mountain roads and steep grades call for trucks with top performance and alert, skillful drivers.

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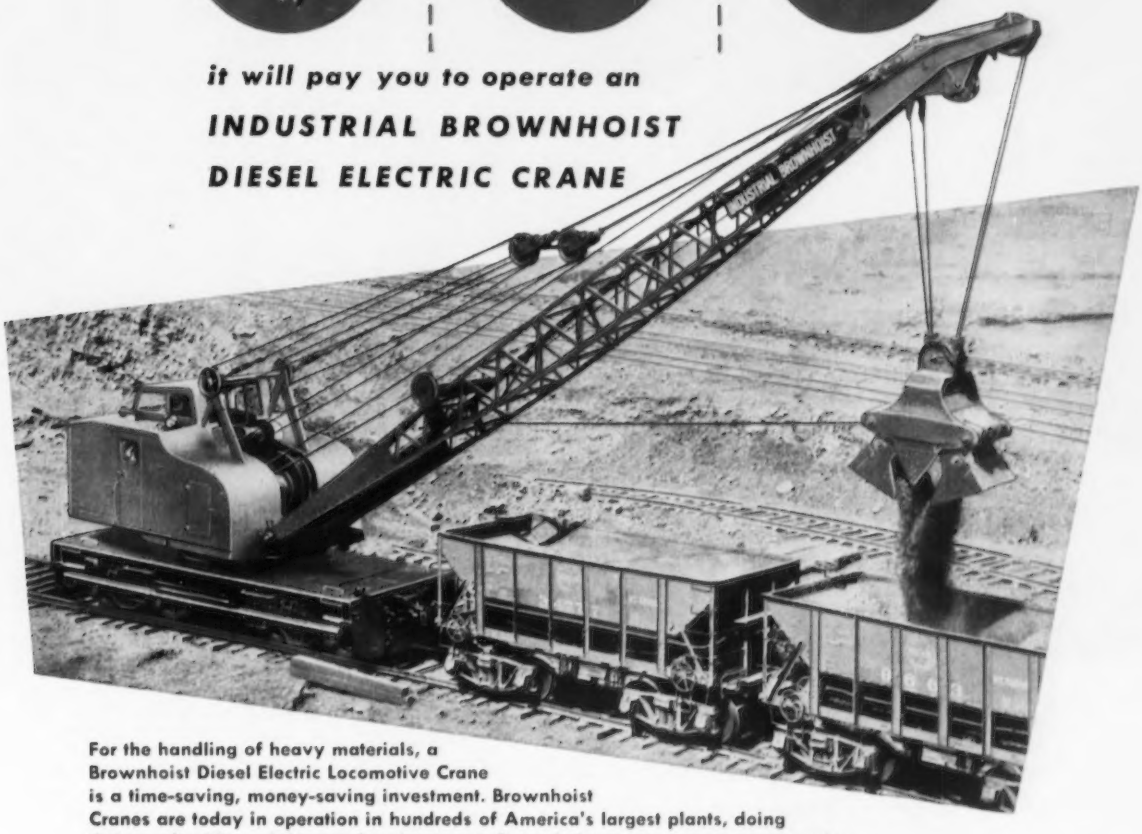

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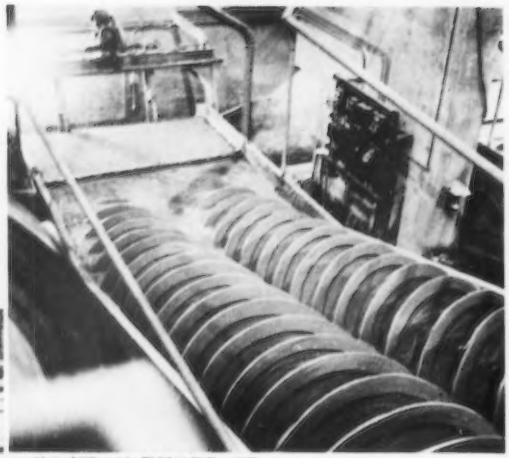

The Star Mill, Burke, Idaho, owned by The Bunker Hill Co and operated by Hecla Mining Co These two 48" Duplex Type S Akins Classifiers were furnished in 1936

THE BUNKER HILL COMPANY

Kellogg, Idaho. Two 48" Duplex Type S Akins Classifiers were installed in 1947 and another one in 1957.

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Ill.-Ky. (*Continued*)

timbered by Rosiclare Co. in recent months.

Green Flourspar Co., new in the mining field, has completed construction of a 300-ft rectangular shaft on the Ora Spivey property in Hardin County, Ill., and is driving a cross-cut to the vein. Shaft construction was under contract to J. W. Patton and Sons, of Elizabethtown.

MAINE

Production of beryl, feldspar, gem stones, mica, columbite, spodumene, peat and slate in 1955 were valued at more than $1.2-million, up almost 43% over 1954, according to the state geologist. Exploration, he notes, is being conducted widely by more than six mining companies, with four using geophysical methods, one using diamond drilling and another conducting underground exploration. Total mineral production for 1955, including cement and clays, was more than $13-million.

MINNESOTA

Preliminary operations have begun at the Norpac in North Hibbing by dragline and trucks. First material removed will be used to build roads and a fill for the conveyor belt line and stacker base. When this is completed, stripping will be moved by the big dragline and the 14,500-ft long conveyor. This is longer than was required at the South Agnew and Morton mines which this equipment also stripped. Norpac is expected to produce ore in 1959.

At the Hunner mine, the new sizing plant has been completed and is in operation. Ore sizing facilities have been installed or improved at Hanna Company's South Agnew, Patrick and Harrison mines. As a result of research by steel plants, the importance of grade and structure of iron ores is being stressed. Sizing of ores—separating coarse from fines—is a result of this. It helps to control the structure of ores shipped and to produce a more uniform product.

A belt conveyor was placed in operation April 13, replacing loading into trucks by the dragline at M. A. Hanna's Musser mine.

Lake Superior Geology Club held a meeting at the University of Minnesota, Duluth Branch Science Auditorium, May 15. Principle speaker was Dr. S. S. Goldich of the University of Minnesota. His subject was "K40/A40 Dating of Rocks from the Lake Superior Region."

Minerals Beneficiation Sub-Section of the Minnesota AIME held a dinner meeting at Chisholm May 14. Speaker was C. K. McArthur, manager of the National Lead Co. pilot plant at Grand Junction, Colo., whose uranium talk was illustrated by slides. He was formerly

Why a yieldable type of roof support?

When you are driving a tunnel or drift through formations subject to squeezing pressures, the overburden usually shows only a slight tendency to form its own pressure arch around the opening. Thus some sort of artificial roof support must be quickly created to induce the natural arch, and thus stabilize the surrounding forces as quickly as possible.

Rigid supporting devices cannot indefinitely withstand these dynamic forces; we know of at least one case where 14-in. timbers failed in a matter of weeks. In fact, the more rigid the support, the more aggravated the situation may become. And that's where Bethlehem's Yieldable Arch steps in.

The Yieldable Arch was designed to "give," allowing the overburden to relax slowly into its own natural arch. The more the Bethlehem Arch yields, the more the stress is transferred to the surrounding material. When equilibrium is reached, the Yieldable Arch stands pat. This is why the yielding feature is more important than the actual strength of the Arch.

Yieldable Arches are made of U-shaped rolled-steel segments, heavily flanged to resist torsion. They nest into each other at points of overlap, where they are clamped together with heavy U-bolts. These bolts are drawn tight enough to hold fast under normal pressures; when the pressures become excessive, friction in the joint is overcome and the arch set yields before deformation occurs.

Because of this, and because they are recoverable, Bethlehem Yieldable Arches usually pay for themselves within their first year of service. Some installations have paid their way in less than six months! Why not call in a Bethlehem engineer and let him give you the full story on the Yieldable Arch?

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BETHLEHEM STEEL

BETHLEHEM STEEL

Minnesota (*Continued*)

with the Cleveland-Cliffs Iron Co. on the Mesabi range.

Minnesota Power & Light Co., Duluth, has announced that an agreement has been made with the Erie Mining Co. which provides for interconnection of electric transmission lines of the two companies. Electric power will be interchanged as conditions require. Approximately six miles of 138,000v line, in addition to other facilities, will be built to connect the two systems.

Iron ore shipments from the Lake Superior district are still behind corresponding dates for 1956; but, because of the strike last year, the difference should decrease later in the season.

Erie Mining Co.'s pilot taconite plant at Hoyt Lakes has now produced over 1-million tons of pellets. The big new plant will begin production during the year.

Mahoning mine of Pickands, Mather & Co. where W. D. Webb is mine superintendent, has attained a world safety record by operating a total of 2,875,085 man-hours with no disabling injury between Feb. 1, 1952, and Dec. 31, 1956. The record has continued since then to pass the 3-million mark in mid-April.

33rd annual meeting of the Lake Superior Safety Council was held in Duluth May 23 and May 24. with an attendence of more than 700 men, mostly from the Lake Superior area. Some 50 mining and industrial companies displayed exhibits of safety and operating equipment. President F. G. Michels presided at the two-day meeting. Thursday morning F. J. Haller, vice president of North Range Mining Co., Negaunee, Mich., spoke on "Management's Viewpoint of Safety." He was followed by R. F. Wilson, manager of safety for Oliver Iron Mining Division, who gave a "Review of Injuries in the Lake Superior Region;" and John E. Tepoorteh of Wisconsin Schools of Vocational and Adult Training, Madison, whose subject was "Training for Safety." Last speaker of the morning was Willard E. Parker, industrial psychologist of Personnel management Consultants, Flossmoor, Ill. His talk on "Personality Factors in Safety" developed a somewhat new slant for the men whose work is to increase safety and decrease accidents at the mines.

The Thursday afternoon session was divided into two groups for open pit and underground discussions. The open pit section heard talks by Norman G. Helland, assistant general superintendent of the Hibbing-Chisholm district for Oliver Iron Mining Division, on "Safe Operation of Power Shovels in Open Pits," "Supervisory Training in Churn Drilling" by Bruno Scipioni, assistant chief mining engineer and Peter Del Greco, foreman of drilling and blasting, both from Virginia of Oliver's eastern district, and by Thomas W. Richard, Silver Bay, Minn., training supervisor for Reserve Mining Co., on "Safety in Taconite Plant Operations," a subject of timely and increasing importance to the Lake Superior district. The underground group was attended chiefly by men from the Vermilion range of Minnesota and the Michigan iron ranges and copper mines. Talks were given by R. J. Marcotte of Calumet & Hecla, Calumet; Al Cigalio of Pickands, Mather & Co. and by Jack Warren of the Anaconda Co., Butte, Mont.

Kenneth Duncan, retired manager of mines for Pickands, Mather & Co., acted as toastmaster at the Thursday evening banquet.

On Friday the two groups were combined and talks were given by R. F. Knoblock of the U. S. Rubber Co., Chicago; a second paper by Willard Parker on "Improving Morale Through Leadership" and a panel discussion on "Safety Workshop" lead by Al Kolu, Duluth, of Pickhands, Mather; George A. Borgeson, Hibbing, of M. A. Hanna Co. and S. B. Slade, Virginia, of Jones & Laughlin Steel Corp.'s Minnesota Ore Division.

Officers for the past year have been: F. G. Michels, Negaunee, Mich., of North Range Mining Co.; A. J. Stromquist, Ishpeming, Mich., Cleveland-Cliffs Iron Co., vice president; A. J. Windl, Duluth, Oliver Iron Mining Division, treasurer; and A. D. Look, Duluth, of the U. S. Bureau of Mines, secretary.

MICHIGAN

Inland Steel Co. is conducting exploratory drifting in its Macdonald property from the adjoining Sherwood mine. The Macdonald was diamond drilled in 1954 an 1955 when twelve 420 ft holes were put down. One of these was deepened and two other holes drilled, averaging 1870 ft in depth. Early in 1956 preparations were begun for drifting into the Macdonald from the Sherwood. Over 1900 ft of drifting has been done at a cost of about $250,000. Another year or more may be required to determine whether a commercial orebody exists in the Macdonald. The property consists of two forties which are south and east of the Sherwood. The Sherwood uses underground belt conveyors and present plans call for mining the Macdonald ore through the Sherwood shaft if results of the exploratory work warrant its mining.

Hanna Coal & Ore Corp. has announced

AEC List of Processing Plants Adds to Total

ATOMIC ENERGY COMMISSION has released a revised list of operating and planned uranium processing plants in the U.S. (See *E&MJ*, February 1957, p 91). All, with the exception of the mill at Monticello, Utah, are privately owned and operated, under individually-negotiated contracts whereby AEC purchases concentrate. As of May 15.

		Tpd Ore	Estimated Cost
Operating:			
1. Rifle, Colo.	Union Carbide Nuclear Co.	280	$ 1,600,000
2. Uravan, Colo.	Union Carbide Nuclear Co.	1,100	5,000,000
3. Durango, Colo.	Vanadium Corp. of America	430	813,000
4. Naturita, Colo.	Vanadium Corp. of America	350	1,000,000
5. Grand Jct., Colo.	Climax Uranium Company	350	3,088,000
6. Shiprock, N. Mex.	Kerr-McGee Oil Industries	500	3,161,000
7. Grants, N. Mex.	Anaconda Company	3,000	19,358,000
8. Salt Lake City	Vitro Uranium Company	550	5,500,000
9. Monticello, Utah	Government-owned	600	5,000,000
10. Edgemont, S. Dak.	Mines Development, Inc.	300	1,900,000
11. Tuba City, Ariz.	Rare Metals Corp. of America	250	3,600,00
12. Moab, Utah	Uranium Reduction Company	1,500	8,250,0000
	Sub totals	9,210	$ 58,270,000
Mills Under Construction or Contracted:			
1. Bedrock, Colo.	Atomic Fuel Extraction Corp.	200	$ 2,072,000
2. Mexican Hat, Utah	Texas-Zinc Minerals Co.	775	7,000,000
3. Ford, Wash.	Dawn Mining Co.	400	3,100,000
4. Split Rock, Wyo.	Western Nuclear Corp.	400	3,600,000
5. Rifle, Colo.	Union Carbide Nuclear Co.	1,000	*8,500,000
6. Maybell, Colo.	Trace Elements Corp.	300	2,208,000
7. Gunnison, Colo.	Gunnison Mining Co.	200	2,025,000
8. Fremont Co., Wyo.	Lucky Mc Uranium Corp.	750	6,900,000
9. Grants, N. Mex.	Homestake—New Mexico Partners	750	5,325,000
10. Grants, N. Mex.	Homestake-Sapin Partners	1,500	9,000,000
11. Grants, N. Mex.	Kermac Nuclear Fuels Corp.	3,300	16,000,000
	Sub totals	9,575	$ 65,730,000
Recap:			
12 mills operating		9,210	58,270,000
11 under construction or contracted		9,575	65,730,000
	Grand total	18,785	$124,000,000

*New Union Carbide mill at Rifle, Colorado, to replace one now operating. Adjust totals accordingly.

Announcing HI-CAP*...

New Du Pont Explosive

designed for economy in blasting operations

Hi-Cap . . . the newest addition to the Du Pont explosive family . . . will assure economy in many blasting operations.

The reason is simple. Hi-Cap answers the demand for a low-priced, cap-sensitive, water-resistant explosive with high strength for all-around shooting.

Hi-Cap is available in 12½ and 25 lb. bags for pouring into small diameter dry holes and in 23-G cartridges of 5" diameter and above.

When Hi-Cap is poured in small diameter holes, a 40% dynamite primer, 1¼x8, is recommended for detonation.

For maximum safety, charges of Hi-Cap should be detonated with Primacord in the usual manner using Du Pont MS delay connectors whenever practical. With this method of firing, you have no blasting caps on the job until the shot is ready to fire.

Notice how the 23-G cartridge is crimped to facilitate loading in the hole. The tape bail serves as a carrying handle, and also for lowering. Since no outside case is required for the 23-G cartridge, there is no packing material or debris left to clean up after the shot is loaded.

Call your Du Pont representative for more information on low-priced Hi-Cap or write: E. I. du Pont de Nemours & Company (Inc.), Explosives Department, Wilmington 98, Delaware.

*Registration applied for.

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DU PONT

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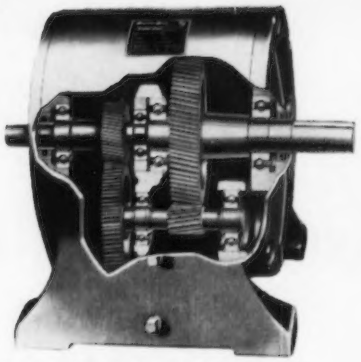

Cutaway View Double Reduction Type RD

Double Reduction Type RD

Triple Reduction Type RT

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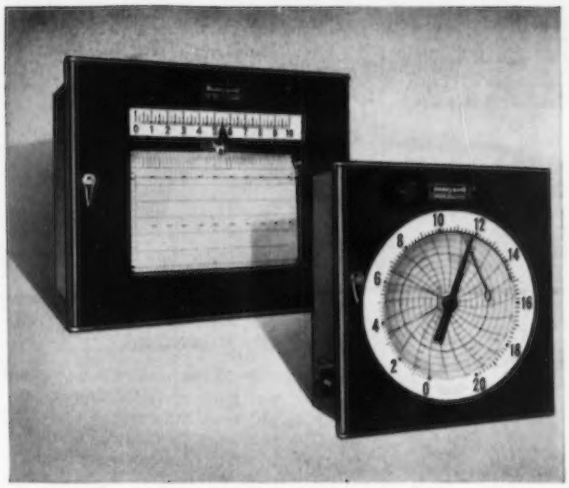

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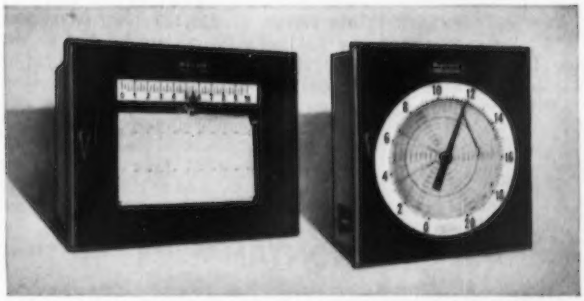

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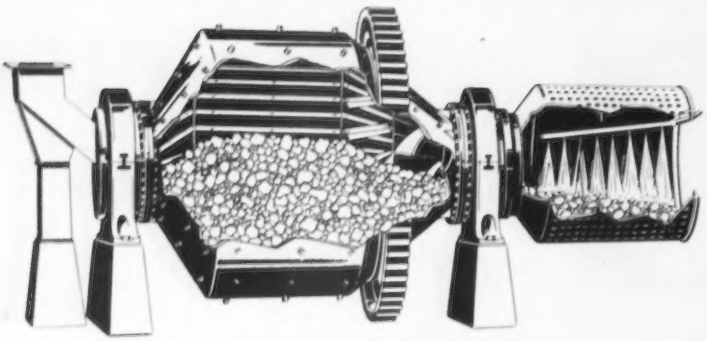
BROWN INSTRUMENTS
First in Controls

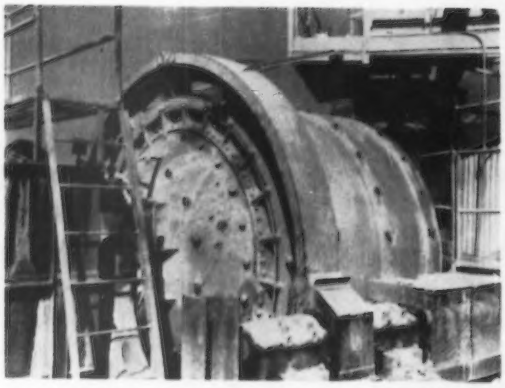
HARDINGE SCRUBBERS FOR PIT-RUN MATERIALS



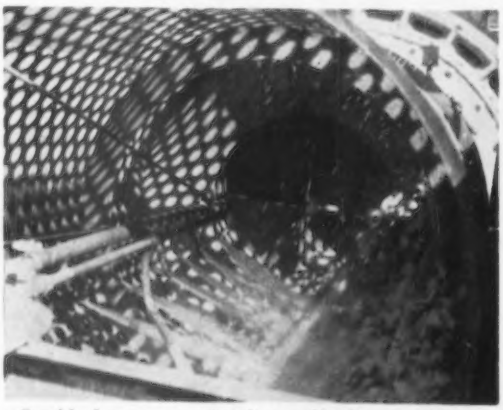
Large diameter, short length trunnions permit chute feeding of unsized ore and rock at rates up to 600 tons per hour.

The mass loading and ball-mill action in the scrubber quickly and completely slurries the clay and dirt, permitting ready separation on washing screens or trommels.

Complete specifications upon request. Bulletin 37-B-1.



Crushed dolomite presents a difficult cleaning problem. The Hardinge 10′ x 66″ scrubber above is doing the job satisfactorily in a California dolomite plant.



Scrubbed stone emerging from a Hardinge Scrubber into a washing trommel which rotates with the Scrubber.

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Michigan *(Continued)*

that it has "shelved indefinitely" plans to build a low grade iron ore concentrating plant at the old Groveland mine, twelve miles north of Iron Mountain. The company built a pilot plant there in 1951 and experimented on the ore for a year, concentrating low grade ore into powder and shipping out 30,000 tons for testing. In 1952 it was announced that the operation was successful. Announcement added that the delay does not mean that Hanna has abandoned its original plans, but that more engineering study is necessary.

Iron County Engineers Club annual meeting was held at Old Caspian May 16 with 140 men attending. Officers of the club are: John R. Quayle, president; Arthur Martini, vice president; John Torreano, treasurer, and Tom Hecker, secretary. Monthly meetings will be resumed in October.

The new Homer-Wauseca shaft, on which work was begun on Dec. 3, 1956, is off to a good start. The 20-ft diameter shaft was mucked out down to the ledge and then concreted up to surface. A 41x55x12-ft reinforced concrete base, containing 806 cu yd, was poured in 21½ hours. This will carry the permanent headframe after the temporary one has served for sinking the shaft to a depth of 2600 ft below collar.

April ore shipments by the Chicago & North Western Railroad to the Escanaba docks were 676,326 tons. This was a new record for that month, breaking the old record of 625,119 tons established in 1951. This was largely due to the delayed opening of the Lake Superior harbors—Ashland in this case—because of ice conditions in Whitefish Bay and the Soo. Sixty-seven boats loaded at Escanaba in April as compared to 45 in April of 1956. Loading from the Escanaba docks in May continued heavy.

MONTANA

Minerals Engineering, Grand Junction has acquired a new and rich tungsten orebody on Calvert Creek, in Montana. The Calvert ore averages 1.06% vanadium oxide in addition to tungsten, president Blair Burwell said. Tungsten in the orebody would be worth $14-million at present world prices.

Meanwhile, Minerals has closed down its lower grade Browns Lake tungsten property and stepped up operations at the Calvert Creek deposit.

Burwell Sr., president of Minerals and a resident of Grand Junction, Colo., reported to shareholders that Calvert Creek reserves had been hiked to 412,000 tons of developed ore and 100,000 tons of indicated ore.

This ore averages 1.06% WO_3 and may be compared in grade with ore found in Utah, eastern Nevada and southern Idaho which under the $63 a unit Federal purchase plan was profitable even though grade was as low as 0.30% WO_3 at the mine.

GENERAL

NYGEN® TIRES

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Where time is a vital factor, the sure-footed, crawler-like traction and flotation of General Truck Tires can be counted on to get the job done faster and for less.

Built tougher for the toughest jobs with exclusive Nygen Cord construction and featuring extra wide treads for positive traction, Generals are unexcelled for drive, durability and dependability.

Put Nygen-built General Truck Tires to work tomorrow on your toughest job and let them prove their worth in time saved and profits made.

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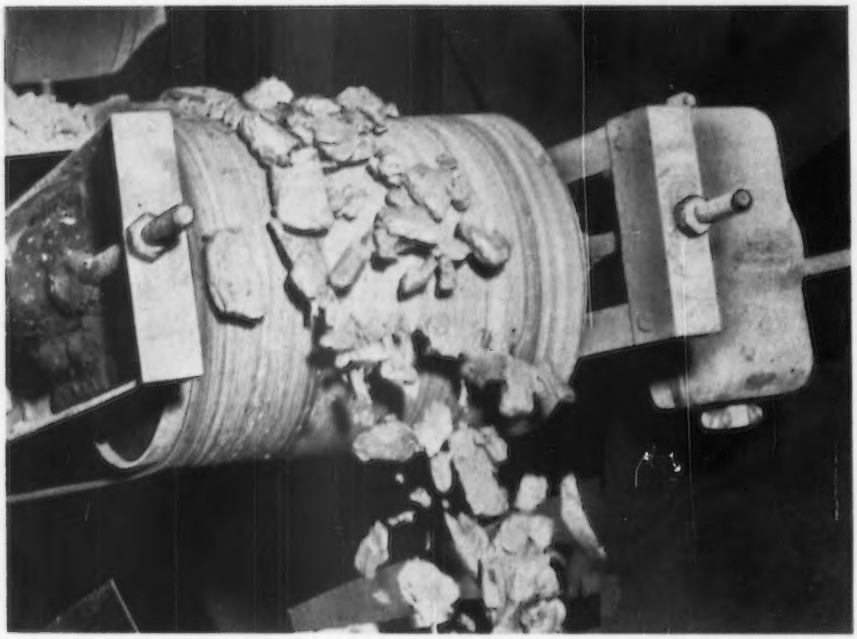

One of three 12-in.-dia. by 16-in.-width Stearns electromagnetic pulleys removes tramp iron as conveyor delivers high-quality clay to hopper before final processing.

Largest Clay Producer Takes No Chances with Product Purity...

Stearns Magnetic Pulleys Remove Tramp Iron from Ceramic Clay

CHESTER GULICK, *Manager*
Kentucky-Tennessee Clay Co., Inc.

Operating 'round the clock, three Stearns electromagnetic pulleys effectively remove traces of free iron from 300 tons of ball clay daily at Kentucky-Tennessee Clay Company, Inc. Located near Mayfield, Kentucky, the firm is the nation's largest producer of ball clays used in the manufacture of hotel china, art novelties, ceramic tile and sanitary ware.

The Stearns pulleys extract tiny amounts of tramp iron from disintegrated clay prior to grinding and air flotation. Complete and positive removal is important not only for product quality but also for protection of costly processing machinery. Says Manager Chester Gulick, "The Stearns magnetic pulleys enable us to provide customers with a much cleaner finished product than would be possible without such protection.

"Since we installed the Stearns pulleys in 1941, they have done an outstanding, trouble-free job of tramp iron removal. Maintenance has been normal, with no appreciable downtime."

This 16-year record of efficient performance is typical of Stearns equipment in hundreds of processing installations. The Stearns line of *engineered* magnetic pulleys is complete — electromagnetic or permanent types, full range of standard widths and diameters. You can easily select the ideal unit for your application. Call your Stearns representative for details, or write for free literature.

46

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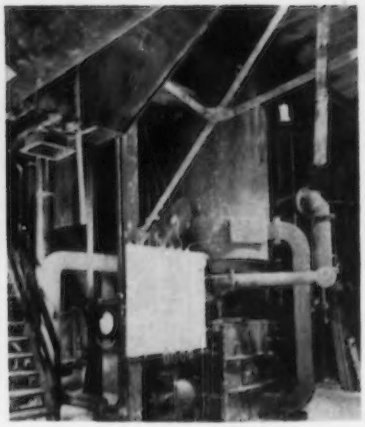
ONE OF THE LARGEST ground mica plants in the U. S., is near Taos, N. M.



FLUID ENERGY SYSTEM classifies ore.

Santa Fe Firm Mines and Processes Ground Mica

PETACA MINING CO., Santa Fe, N.M., is producing some 90 tpd of ground mica from its plant in northern New Mexico.

Petaca is one of four mica processing firms which use compressed air for fine grinding. In compressed air process, mica is mined, processed and finally fed to a pulverizing and classification system at minus ½-in. and plus 18 mesh which produces closely controlled end particle sizes. Compressed air system is favored because it reduces "iron contamination," frequently associated with other methods.

A fluid energy mill system, the Majac Jet Pulverizer, does the exacting job of air pulverization and classification. Wet or dry mica is fed by a screw feeder into the pulverizing chamber. Here the mica is impacted against itself, while entrained in two directly opposed, high velocity, streams of air. The mica is then carried to a classification section above the grinding chamber which provides precise control of the end product by controlling the rotational speed of the classifier blades and the amount of fan air introduced in this section, so only particles of suitable size are discharged from the mill. Oversize particles are returned to points at the ends of the opposing high pressure air nozzles, where they are entrained in the jets for further reduction in particle size.

Wet mica is dried by means of the heat content and moisture-carrying capacity of the air. After discharge from the mill, the mica is conveyed (still in air suspension) to a collection system, and deposited in appropriate end-product bins.

Jet pulverizer uses power provided by 2500 cfm of free air, from a Worthington compressor, compressed to 100 psig and heated to 800 deg F, and then distributed to the entrance of the two opposing high pressure nozzles.

Montana (*Continued*)

Calvert Creek is mined by open pit methods and is competitive with world-market produced tungsten despite depression of prices.

Production potential of Minerals' tungsten reserves in the U. S. and Mexico is equal to 50% of present American consumption, Burwell estimates.

Burwell added that Minerals Engineering has blocked out 52-million tons of iron ore at its Carter Creek deposit in Montana and that several steel companies are interested in buying ore.

NEVADA

Consolidated Coppermines Co. has announced plans to spend $7-million in White Pine County to broaden the firm's operations through diversification and participation in oil and gas programs begun in 1956. The plans call also for modernization of equipment to reduce production costs. During 1956 the firm spent $3,691,909 developing copper properties in the Ely area, according to president Chester Tripp. Operations at the Tripp Pit cost $2,998,927, he said, and $469,187 was expended on the Veterans Pit. Since 1955 the Tripp Pit has produced 15,044,000 tons of overburden and 2,881,000 tons of ore. A total of $5,693,967 was earned in 1956.

Electro-Chemical Co. is providing capital to rebuild the Cyrus Noble mill in the Searchlight area of Clark County. When the work is completed the mill is expected to process 100 tpd. The ore to be handled contains seven mineral values which the mill owners hope to extract through a new milling process.

Work has been resumed on the Bonanza Silver mine near Yerington, to determine the extent of orebodies. Assays of exposed feeder veins run to 405 oz of silver per ton plus substantial values in copper and lead. W. L. Stuart, president of the Coast Mining & Development Co., owners of the property, says that uranium has also been found on the site, and will be developed later. C. L. Stuart is superintendent.

Nevada Massachusetts Co., near Mill City in Pershing County, went on a reduced work week in May because of the unfavorable situation in the tungsten market. Two work weeks will be run together for a period of ten straight days after which there will be a four-day shut-down. In a letter to employees the company officials expressed regret at the necessity of the cut-back but said the only alternative was complete shut-down. Failure of the Government to adopt a promised long-term non-defense minerals program is given as the reason for the reduction in operations. Nevada Massachusetts Co. is one of the nation's largest tungsten producers.

Gold Streak Mining & Milling Co. is erecting a mill east of Cherry Creek in Humboldt County to process ore from the firm's Gold Streak Mine in the Schellburne mining district. Ore from Louis Campanella's Calcite No. 5 mine in the Cherry Creek district will also be processed. Originally a gold and silver mill purchased last summer in California, the mill is now being altered to handle tungsten. It will be a gravity mill and will handle from 30 to 60 tons of ore in 24 hours, depending on the hardness of the rock.

Wah Chang Mining Corp., which operates the Lincoln Mine at Tempiute in Lincoln County, has completed work on the three-compartment winze from the 600-ft tunnel level. Stations have been cut, and development work is progressing on the 760- and 900-ft levels. A 63-mile high tension power transmission line has been completed and transformer and take-off stations erected. Hoover Dam power is now available to the mine and mill. Paved highway 25 miles in extent has been completed from Highway 93 at Crystal Springs toward the mine, and another 25 miles of road from Warm Springs toward the property is under construction. Contract for construction of the intervening 50 miles will be let this month.

Apex Minerals Corp. has struck coffenite ore averaging 1.33% uranium for a width of 10 ft at its property near

"Talk up" increased production—greater safety...with these M-S-A COMMUNICATION SYSTEMS

M-S-A MINEPHONE

Dispatcher sends orders instantly and simultaneously to all motormen with this modern, underground two-way voice communication system. Motormen receive and reply while trips are in motion—keep haulage movements coordinated with production demands. This results in smoother, faster, and more continuous trip movements throughout the mine.

Messages clear tracks for outgoing loaded trips and incoming empties. This system puts an end to traffic tie-ups, errors and accidents; prevents excessive stop-and-start strain on equipment. Write for more detailed information.

• Dispatcher sends orders to motormen . . . routes right-of-way traffic . . . receives reports on positions and station conditions.

• "Jeep" operator requests instructions from dispatcher and maintenance shop for section assignment . . . speeds emergency repair.

M-S-A HOISTPHONE

For accurate, instant response between the hoisting engineer and cage, here's the voice communication system to install. Whatever the job—load leveling—shaft repairs—shaft inspection trips—passenger transportation—the M-S-A HoistPhone provides better safety and efficiency through dependable, continuous two-way voice communication at any level, and while the cage is in motion.

Requires no special training . . . simple to use . . . dependable in operation. Write for further information.

• The hoisting engineer is able to control all movements of the cage by communicating with cage rider over the M-S-A HoistPhone.

• Worker uses microphone in cage to tell the hoisting engineer where he wants to go. Loudspeaker mounted on top of cage.

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TORQUE RATINGS:
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STEEL frame ...of fabricated plate supports all rotating elements—provides double the ability of iron to maintain vital alignment of revolving elements, even under shock load or external impact.

STEEL housing...will not fracture, serves only as protective cover and lubricant reservoir. Therefore, lubricant supply is safeguarded.

STEEL tie-rod and straddle-mounted tie rod brackets...are fastened to heavy steel frame by steel bolts in double shear.

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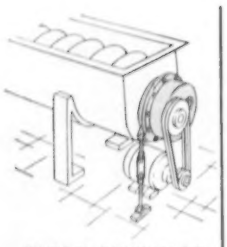
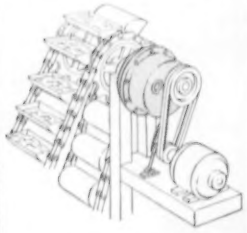
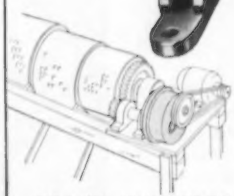


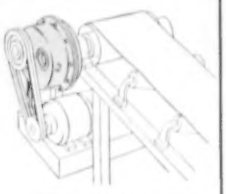
SCREW CONVEYOR



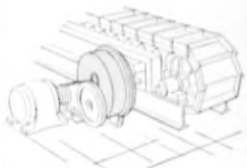
BUCKET ELEVATOR



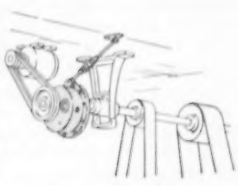
GRAVEL CLASSIFIER



BELT CONVEYOR



APRON FEEDER



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FALK

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Nevada (*Continued*)

Austin, according to Fred Vollmar, president of the company. Discovery was made by diamond drilling. Easterly at a distance of 50 ft, and at a depth of 32 ft, the drill has cut 6 ft of coffenite ore averaging more than 1%. Vollmar said. The company official predicts that the Austin property may develop into one of the nation's largest uranium producers if present conditions are borne out.

NORTH CAROLINA

North Carolina Legislature on June 8 enacted into law a bill providing that "wastes" as defined in the state stream pollution laws shall not mean silt, soil and its natural content which may be discharged into the stream.

Southeastern Minerals, Inc., and Southeastern Asbestos Corp, both of Asheville, N. C., have obtained certificates of incorporation from the North Carolina Secretary of State. Clyde Norton and Janet Norton of Old Fort, N. C., and Philip Hoyt of Pheonix, Ariz., are incorporators of both firms.

Southeasten Minerals has authorized capital of $100,000 and is authorized to deal in minerals, ores and real estate. Southeastern Asbestos has authorized capital stock of $300,000 and is authorized to deal in real estate or mineral interests.

The North Carolina Legislature has enacted into law a bill requiring the state's well diggers to supply the State Department of Conservation and Development with samples of well cuttings.

OREGON

Lakeview Mining Co. which believes there are 500,000 tons of uranium ore at its White King mine 16 miles northwest of Lakeview, has applied to the AEC for construction of a 3-million solvent extraction plant at Lakeview. The proposed plant would have a capacity of 350 tpd.

Howard B. Dutro, chief geologist for the Colorado-owned company, said the White King deposit is rich enough to rank it among the 30 top uranium mines in the U. S. The company also holds the nearby Lucky Lass mine, unexplored but believed of equal value.

Dutro said the company has invested more than $1-million in the mine and exploration work. More than 100,000 ft of core drilling has been done.

An exploratory shaft goes down 175 ft and has two long tunnels branching off, one at the 70-ft level and the other at the bottom. The exploratory shaft will be continued to 350-ft depth.

An assay office has been established by Albert A. Hanks Co. San Francisco, in Cave Junction, to test nickel ore samples from drilling operations of the Nickel Corp. of America in the southwestern Oregon area. NCA now

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Marions In Bauxite

An electrically-powered Marion 111-M dragline loads out bauxite at an open pit mine in Arkansas. The machine has an 80-foot boom, 4½-yard bucket and long crawlers which give it added stability on soft footing. One of America's largest aluminum companies operates the mine. This same company and several other companies are using 111-M's in their overseas operations.

CONSULT **MARION** MINING SPECIALISTS
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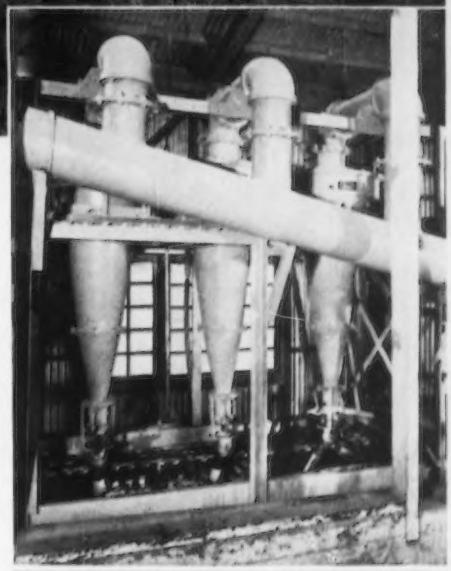

This Krebs Cyclone installation paid for itself in 3 weeks

Acoje Mining Company, Zambales, Philippines is the largest metallurgical chrome producer in the Far East. A year ago Krebs Cyclones were installed to recover values from the slime reject. From the 2,000 gpm of slimes pumped to 3 cyclones, the fine crystalline underflows contain 65 tons per day of 20% Cr_2O_3. This fine scavenged concentrate is cleaned on tables to produce 21 tpd of 50% Cr_2O_3 concentrate adding 6% to 7% to plant recovery.

Krebs Cyclones are available in 17 models for a wide range of classifications. Unique design features, many patented, include a long involuted feed entry which sharpens classification. It also permits increasing the density of the overflow or reducing feed pressure for a specific performance.

We invite your inquiry on the possible application of cyclone classification to your operation and offer the services of our pilot plant for full scale investigations.

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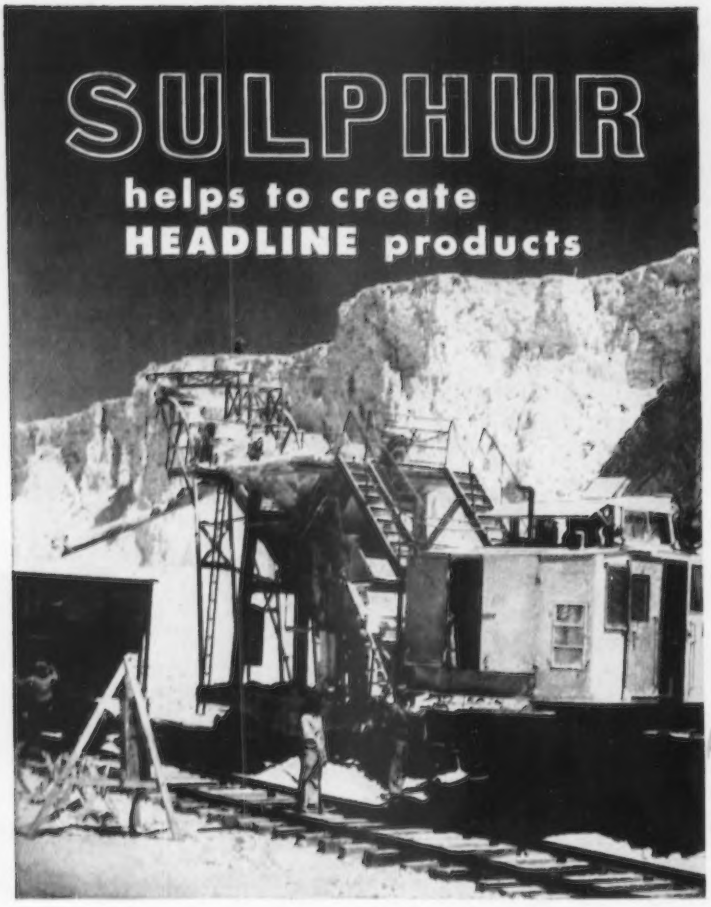

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"Thiokol" synthetic rubber, is an organic polysulfide elastomer. One of its many uses is in solid propellents for long range and high altitude missiles. In liquid form, "Thiokol" synthetic rubber mixed with an oxidizer, is poured into specially designed combustion chambers of rockets. It helps to give stability to the fuel charge and resistance to shock. It promotes uniform burning. When the rocket motor is ignited the mixture burns with great intensity and generates large volumes of gas to propel the rocket.

Solid propellents made with "Thiokol" synthetic rubber have proved their value in rockets over liquid propellents in many ways: they are less costly and easier to manufacture—simple and rugged construction makes handling and launching easier and safer—fuel tanks and complicated feed systems are eliminated.

"Thiokol" synthetic rubber is a product containing a high percentage of Sulphur—its name being derived from the Greek words for sulphur and glue. Here is another example of the continually broadening field in which Sulphur is an important and necessary element.

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BETTER RUBBER FROM START TO FINISH

Oregon *(Continued)*

has three drilling rigs operating on Woodcock Mountain. Work on Eight Dollar Mountain is expected to start soon.

Pacific Nickel Corp., Los Angeles, has taken options on about 12,000 acres in the Red Flats area of Curry County south of Gold Beach between Hunter Creek and Pistol River.

Mrs. Rose Nunemacher, representing Pacific Nickel, said payments in excess of $1-million will be made for the properties optioned if core drilling warrants.

The option was filed the last week in May in the Curry County clerk's office in Gold Beach.

First exploration for nickel ore in the area was done ten years ago by the Oregon Department of Geology and Mineral industries. Later the U. S. Bureau of Mines made test drillings.

UTAH

Continental Materials Corp. (formerly Continental Uranium), has announced acquisition of assets of the Old Texas Mining Co., closed corporation of Dallas, Tex. which has maintained offices in Moab for the last three years.

Old Texas holdings include 775 uranium claims in Utah, Colorado and New Mexico, with several producing properties. Continental stock was exchanged for the Old Texas assets, board chairman Gerald Gidwitz said. Old Texas also retained a royalty interest on properties involved.

Chief Consolidated Mining Co., Eureka, which has been producing lead and zinc continuously since 1909, announced "indefinite suspension of operations," effective June 15.

Cecil Fitch Jr., president and general manager, said the shut down affecting 70 miners presently employed above the 1800-ft level in the property results from massic imports of foreign produced, low-wage-cost lead and zinc.

In September 1954, the firm for the same reason reduced employment from 286 miners to 70 in a shutdown of operations at the Chief No. 1 mine where its principal orebody lays.

Mr. Fitch emphasized that the indefinite suspension of operations does not result from any lack of ore. The Chief, which has produced $150-million worth of lead and zinc in its history, has ample ore, he said.

"But we have been fighting this import situation for 11 years," he said, and "can go it no longer". He praised the "loyal mine crew" and said relations with the United Steelworkers of America AFL-CIO "were excellent."

That mine union had agreed on several occasions to wage reductions in effort to keep the properties operative.

Chief Consolidated thus becomes the last operating metal mine in the Eureka-Tintic district to close down. The district has produced over $500-million worth of lead-silver-zinc since its orginal development in the 1870's.

Salt Lake Tungsten Co., affiliate of Sylvania Electrical Products, Inc. and Minerals Engineering Co., is back into production of 5,000 units of WO_3, natural and artificial scheelite, Blair Burwell, Jr., general manager reports.

The plant had been closed down because of growing inventories resulting from termination of the GSA's buying program which halted when the Goverment agency ran out of money.

These inventories have now been liquidated through new purchase contracts completed with American firms.

Minerals Engineering produces high grade natural scheelite from an upgrading plant located at Industrial Center in Salt Lake City.

Salt Lake Tungsten produces the artificial scheelite from somewhat lower

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SAFETY YELLOW reflects the light . . . it is readily visible in darkness . . . minimizes damage from punctures by machinery and equipment.

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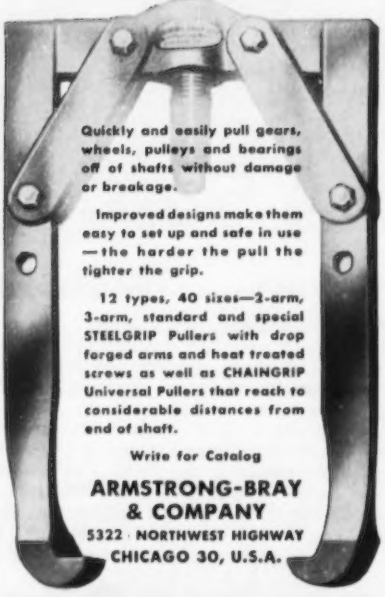

Quickly and easily pull gears, wheels, pulleys and bearings off of shafts without damage or breakage.

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12 types, 40 sizes—2-arm, 3-arm, standard and special STEELGRIP Pullers with drop forged arms and heat treated screws as well as CHAINGRIP Universal Pullers that reach to considerable distances from end of shaft.

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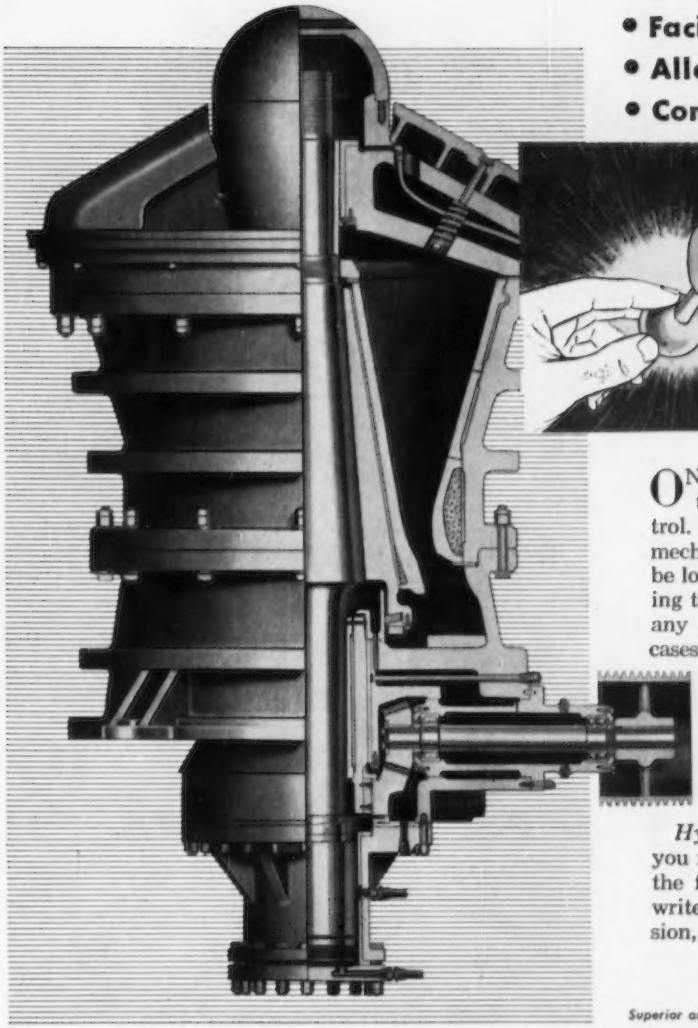
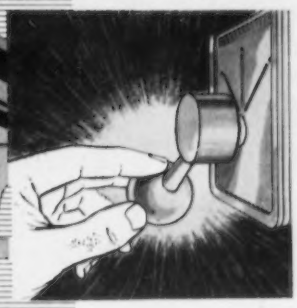


- **Facilitates Emergency Unloading**
- **Allows Rapid Change of Setting**
- **Compensates for Wear**



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Compensating for wear and retaining initial setting or changing setting is also a one-man, one-minute operation. Product size always remains uniform.

Hydroset feature (hydraulic operation) can give you many other profit-building advantages. Get all the facts. See your nearby A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis. Ask for Bulletin 07B7870.

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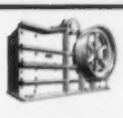
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Gyratory Crushers

Grinding Mills

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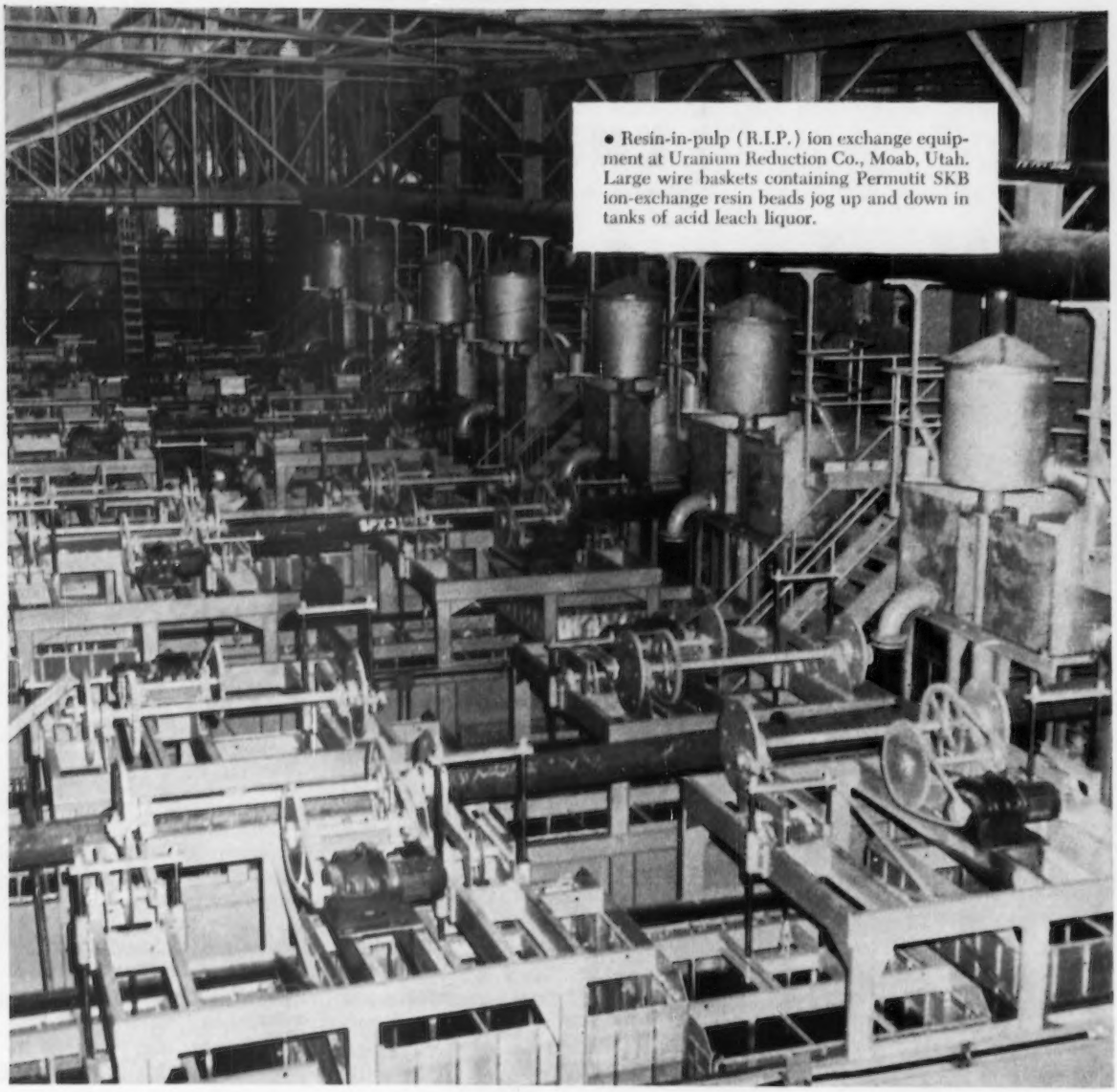

• Resin-in-pulp (R.I.P.) ion exchange equipment at Uranium Reduction Co., Moab, Utah. Large wire baskets containing Permutit SKB ion-exchange resin beads jog up and down in tanks of acid leach liquor.

Uranium Reduction Co. boosts output with Permutit SKB resin

• Uranium Reduction's mill is built around the R.I.P. process, and their engineers constantly look for better ion exchange resins.

After Uranium Reduction started using Permutit SKB resin, they reported higher plant output . . . with no noticeable loss in uranium recovery.

Permutit SKB is used in a number of R.I.P. mills for these same reasons. It was developed especially for R.I.P. uranium extraction. It disperses well, preventing "blinding" of the baskets and improving resin-pulp contact. Its unique chemical structure gives it fast loading for high uranium recovery, high capacity and fast elution. This results in extremely high concentrations of recovered uranium particularly in nitrate elution systems. It also means low precipitation costs and a high purity uranium.

Permutit SK (finer mesh than SKB) offers the same chemical advantages when used for uranium extraction in conventional ion-exchange columns.

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automatically direct the most power to the wheels that are gripping — whenever the other wheels tend to spin on mud, loose sand, ice, snow, etc.

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65

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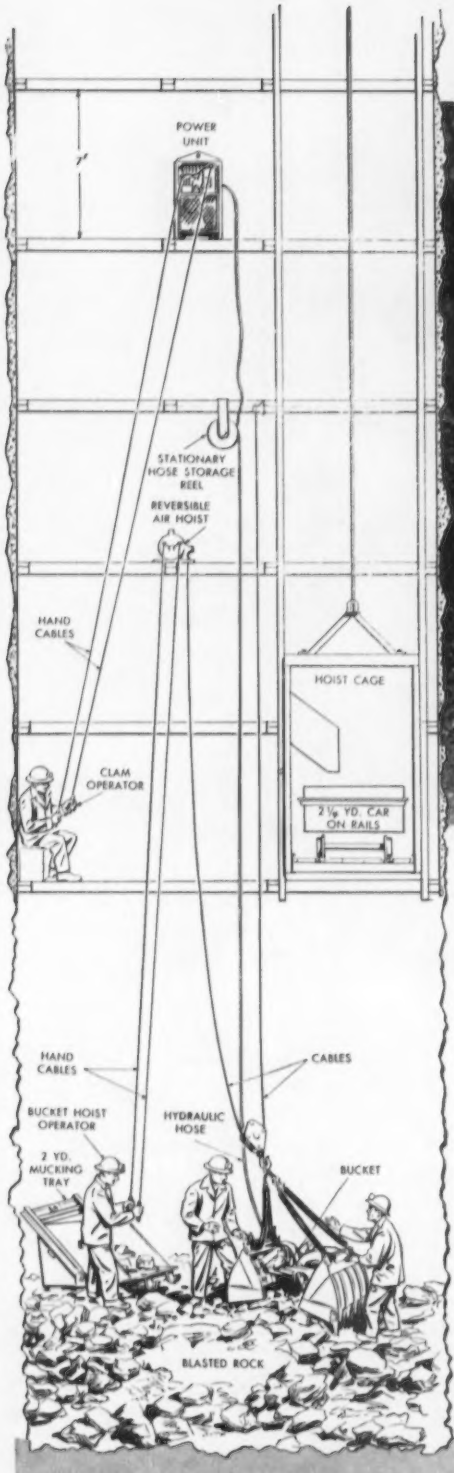
WITH BUCYRUS-ERIE HYDROMUCKER



Here is a hydraulic shaft mucking device that increased production 35 per cent at one mine — and freed 30 per cent of the manpower for other work! Let's look at the reasons why:

1. The hydraulically operated clamshell bucket digs into the muck pile — does not pull away during closing as do rope-reeved clamshells.
2. Clamshell operator can be stationed on a shaft set above the muck pile — out of the way, yet in excellent position to see the operations.
3. Muck can be loaded by the clamshell into a tray or other container which is placed near the digging. When full, this unit is dumped into a skip or car and hoisted to the surface.
4. Very little preparation is necessary to start the mucking cycle. Only the container and hydraulic bucket are hoisted out of the way during blasting, so only minutes are required to connect the hydraulic line and begin mucking.

Sink your shafts the faster, easier, mechanized way with Bucyrus-Erie Hydromucker — ⅜- or ½-yd. capacity. Write for details or see your Bucyrus-Erie distributor. 211H57

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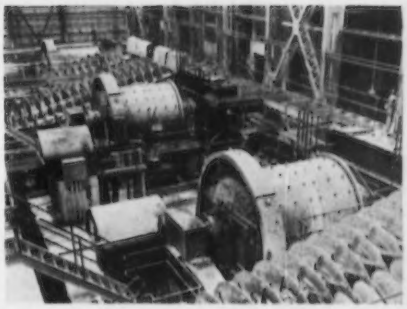
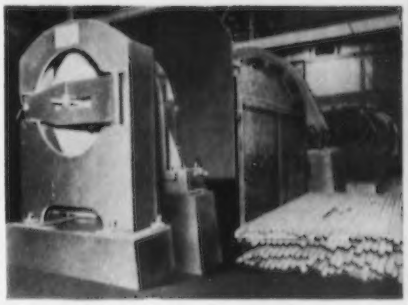
see what Marcy can do for YOU!

Marcy Ball and Rod Mills Increase Capacity up to 33%

Marcy Ball and Rod Mills both incorporate the Marcy principle of grinding... "rapid change of mill content is necessary for high efficiency." This is accomplished by use of the Marcy *full-grate* discharge on ball mills and the *open-end* feature on Marcy rod mills. These features result in a low pulp line which provides an active, effective grinding mass to act on particle size reduction only... there is no wasteful cushioning action by high pulp levels. There is a faster migration of fines than oversize particles, thus less overgrinding. This basic principle of grinding incorporated in Marcy Mills has proved, in hundreds of installations, to give greater output with lower KWH per ton, up to 33% more tonnage compared with the same size overflow mills. Marcy Mills are made in sizes up to 12' 6" diameter. Every Marcy is backed by more than 40 years grinding experience.



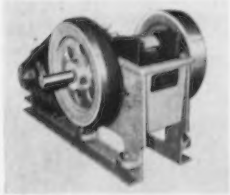


Wilfley Tables
For separation of any material amenable to gravity concentration.

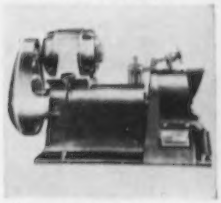
Marcy Pulp Density Scale
Gives direct readings.

Massco-Grigsby Pinch Valves
Rubber and neoprene sleeves. 1" to 14".

6" x 10" Massco Gy-Roll Reduction Laboratory Crusher



4" x 6" Massco Laboratory Jaw Crusher



Massco-McCool Pulverizer
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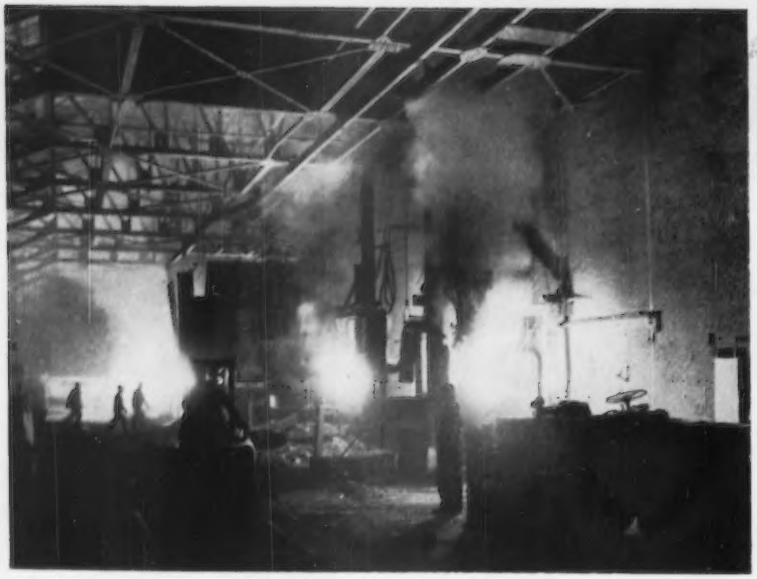


TO KEEP UP with increasing demand for zirconium oxide and silicate products, National Lead Co. is expanding its plant at Niagara Falls, N. Y. Titanium Alloy Mfg. Div. produces both zirconium and titanium products at the Falls. Zirconium salts are presently being used to make wall tile, ceramic ware, enamels and refactories.

Utah *(Continued)*

grade concentrates produced by Minerals' mill at Glen, Mont.

The tungsten refinery also is entering into full scale production of ammonia para-tungstate later this year. Sylvania is making deliveries on necessary high pressure equipment at present for this purpose.

Mr. Burwell declines to estimate what plant output of ammonia para-tungstate will total. However, he belives he can effectively satisfy any needs of Sylvania which will simply calcine the product into powdered tungsten metal at an eastern plant.

Salt Lake Tungsten is selling its WO_3 on the domestic market at present at the world price, or around $20 a unit, plus tariff (about $7.39 per unit).

Mr. Burwell Sr. asserted in his report that: "The present world price has declined below the cost of poduction of a large portion of domestic and world producers and an uncertainty of supply is developing as a result."

Consumption of tungsten, at the same time, continues to increase, he said.

Mr. Burwell says that Minerals Engineering has aimed at: 1. establishing its tungsten operations on a basis free of U. S. Government dependency; 2. diversifying operations of the firm; and 3. Place shares on a regular dividend paying basis.

Standard Uranium Corp. has made its final payment of $500,000 to Monticello, Utah residents, completing purchase for $2-million of the Big Buck claims in Big Indian uranium district of the state.

Recipients of the cash were State Democratic Representative Donald Adams and Don Hayes and Associates, all of Monticello.

The payment vindicates the faith that W. R. McCormick, Moab, had in the properties.

At the time of the sale of the claims, it was asserted the mine would never produce enough ore to pay off the purchase price.

McCormick says settlement sheets from mills are running at the rate $182,255 monthly and that Standard's joint venture on adjoining claims of Col-U-Mex Uranium Corp. has "one-million dollars in ore drilled out so far."

The orebody on these claims will be tapped by August via a 1,648-ft haulage drift now being driven from Standard's workings.

VIRGINIA

Kyanite Mining Corp.'s new Willis Mountain plant, located near Dillwyn, Buckingham County, has been completed and is in full operation. Plant more than doubles output of kyanite concentrate from the company's other plants. Mining is quarry type with froth flotation as recovery method. By-products are sand and pyrites.

WASHINGTON

Development work has been started again at the Mineral Hill mine of Sunny Peak Mining Co. In Okanogan County. Officials said that 2200 ft of air pipe has been put in the main tunnel to prepare for its extension.

Drilling is to start this week to probe the Buckhorn vein, officials said.

Geo-Resource Corp. Spokane consulting firm, has added a geophysics department. Lewis L. Oriard has been placed in charge of new department. The firm, in cooperation with Lands, Inc., Spokane, has acquired an interest in a 480-acre petroleum property north of Anchorage, Alaska.

Company officials also disclosed the acquisition of 52 mining claims in the Russian Creek area of the Metaline lead-zinc district and a half interest in the Red Ridge tungsten claims, both in northern Pend Oreille County.

Ore reserves at the Midnite Mine on the Spokane Indian reservation were said to be worth more than $14-million by Clair Wynecoop, president of Midnite Mines, Inc., Spokane. Midnite owns a 49% interest in the Midnite Mine, and Dawn Mining Co., a subsidiary of Newmont Mining Corp. owns the other 51%.

Wynecoop said that two new uranium orebodies have been discovered at the mine. Drilling, he said, is continuing to the 60-ft levels, and deeper drilling is scheduled later. Stripping operations also are continuing and the ore from the mine is being trucked to the new processing mill that Dawn is building at Ford, Wash., about 20 miles away. The mill is slated to go into operation later in the summer and will process both company and custom uranium ores.

Daybreak Uranium, Inc., said that ore cut recently in a shaft at the firm's Lowley lease on the Spokane Indian reservation has been assayed at a value of more than $85 a ton. Chemical assays, the firm said, were made by Peter Mack, Wallace, Idaho.

Daybreak, a Spokane uranium firm, said the ore showed 0.64% uranium oxide across a four foot width on the north side of the ore zone and 0.45% uranium oxide across four feet on the south wall.

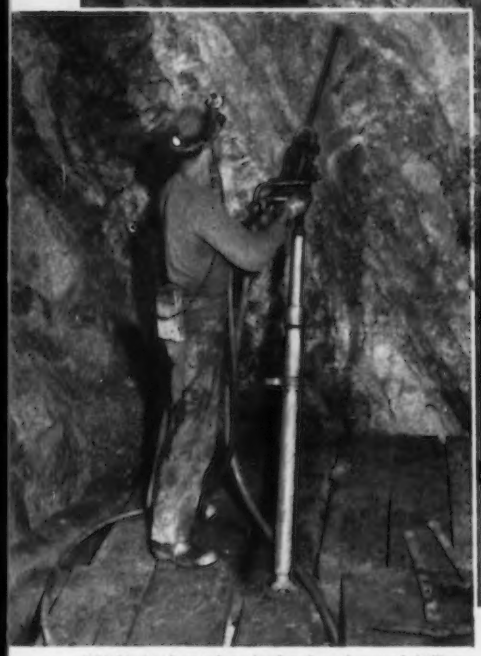
The company said that stockpiling continues at the Dahl lease on Mount Spokane, where workman have exposed a well mineralized fault zone dipping at about 75 deg in addition to the original flat lying ore exposure.

An east-striking shear zone at the Dahl lease has been traced and exposed by trenching or stripping for over 2,000 ft.

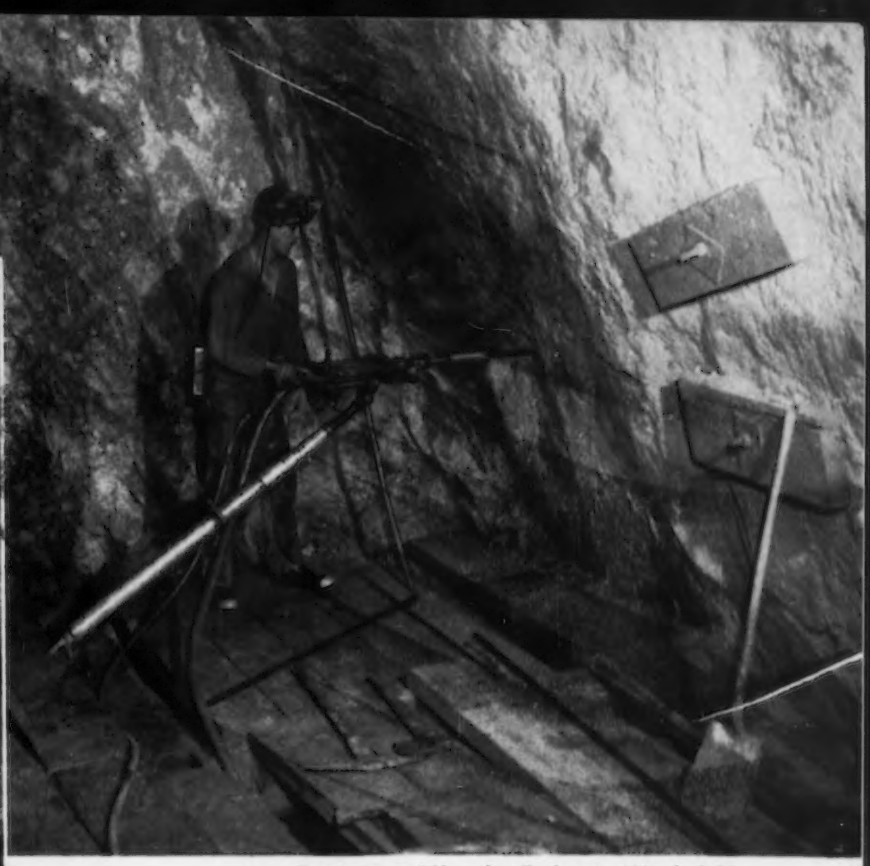
Daybreak officials said they expect to ship about 50 tpd ore to the new uranium processing mill at Ford, less than 50 miles away, which is now under construction for Dawn Mining Co, a Newmont Mining Corp. subsidiary. The 400-tpd capacity mill, which will start operation about August 1, will handle custom ore up to 25% of its capacity. Daybreak has been holding up shipments to Vitro Uranium Co. mill at Salt Lake City and has been stockpiling instead for shipment to the Ford mill.

WYOMING

If Lucky Mc Uranium Corp.'s application to increase the capacity of its uranium mill under construction in the Gas Hills area is approved by the AEC,



H10AL Air Leg takes the hard work out of drilling —absorbs shock, advances the drill into the rock.



Operator can quickly and easily change position for bolting. Air Leg keeps drill in line with hole — reduces drill wear.

One Tool Handles Both Production and Rock Bolting

Le Roi H10AL Air Leg does double duty in typical stoping operation.

Recent design changes reduce wear, ease dismantling

Le Roi's H10AL Air Leg is shown here doing two jobs in a sphalerite stoping operation. Down at the 1900-foot level in a Montana mine, the operator uses both 6- and 11-foot steels while stoping. He makes an 11-foot advance per round in this horizontal breast cut and hydraulic fill stope.

After each blast, he scrapes and bolts the rock walls before drilling the next round. He doesn't need an extra tool. He merely changes the direction of his H10AL Air Leg to quickly and easily handle the rock bolting operation, too.

You can use Le Roi Air Legs as stopers, drifters, or sinkers. They have a full range of drill rotations. An exclusive 11-position feed control allows you to set and maintain any desired feed pressure from 9 psi to full line pressure. That makes it easy to keep lined-up with the hole — reduces front-end wear, eliminates rotation strain — keeps your drill-repair costs down.

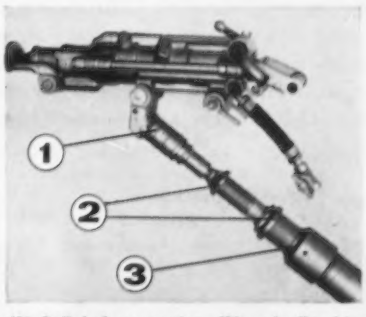
There's no third hose or clumsy "Y" connection. And the Air Leg absorbs the drill recoil. That means an easily handled rig — one that won't tire out the operator, lets him get in plenty of footage with less fatigue.

New Improvements

A sturdy ball-lock connection between drill and Air Leg on recent models permits quick dismantling for easy transportation. This unit is sealed against dirt, and is far stronger than the old bayonet-style construction.

Umbrella drip shields over both pistons keep out unwanted dirt and sludge. Bleed air at both pistons will carry oil to the cup leathers and also prevent dirt from entering the working parts at bushing and piston points. Other mechanical changes and improved metallurgy reduce wear from vibration throughout the entire feeding cycle.

You can choose from several types of Le Roi Air Legs having single or telescopic 3, 4, 5, or 6 ft. feeds. Conversion kits are available to convert older models to the new Le Roi design. Write today for complete information on this useful tool.



(1) Ball lock connection, (2) umbrella drip-shields, (3) sealed dirt-free construction.

WABCO

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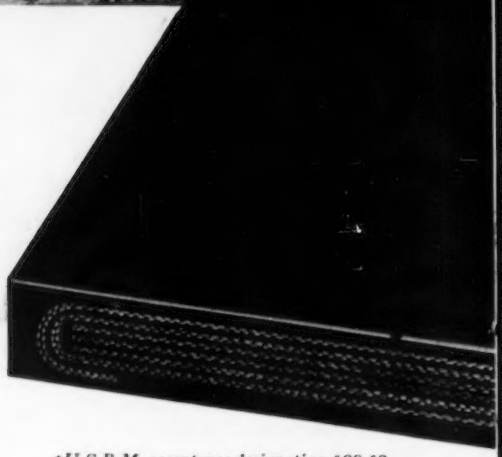

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Order Thermocoal Belting through your Thermoid Distributor, or write direct for detailed information and data sheets.

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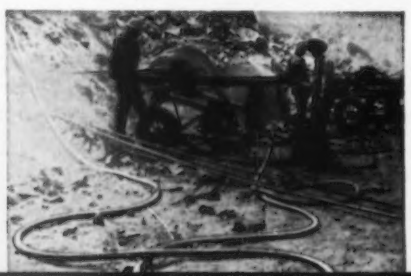

Thermoid

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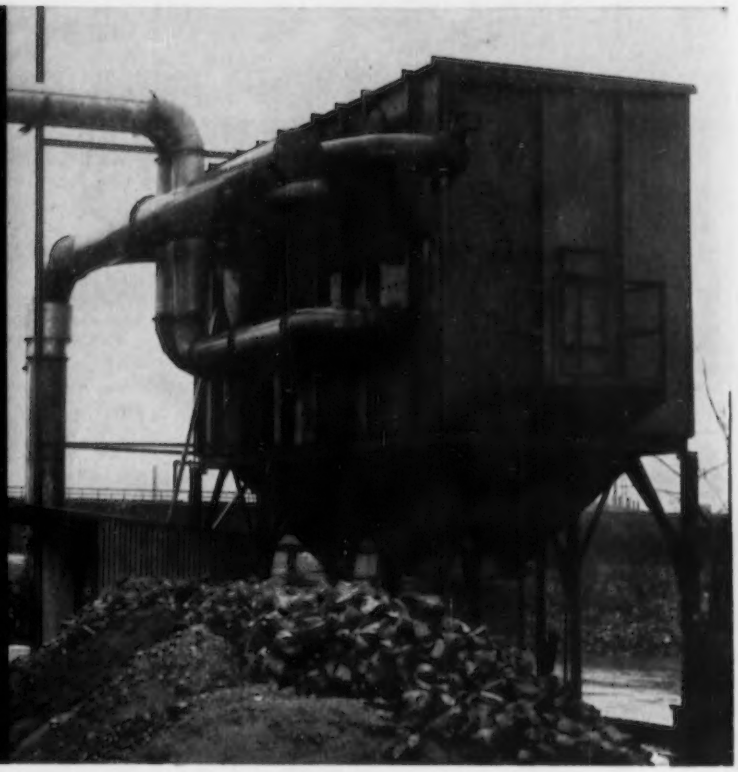
WHEELABRATOR DUSTUBE® COLLECTOR performs king-sized filtration job



ventilates a dozen operations, salvages salable material at Chromium Mining & Smelting Corporation

At the Riverdale, Illinois plant of Chromium Mining & Smelting Corp., the metals that come from its smelting plant are processed and blended. The products made are ferro-chrome, ferro-silicon, and ferro-manganese alloying materials.

All of the various processing operations — crushing, screening, conveying, weighing, container filling and drying — are dust producers. This finely divided metal dust is salable; therefore, recovery is desirable.

To provide required ventilation at these processing stations and also to recover the dust created, a Wheelabrator Dustube Collector is used. This high efficiency cloth tube type collector has three compartments. One of these ventilates the raw materials operations, the other two collect dust and fume from weighing, elevating, mixing, can filling, and drying operations.

The ventilating air is carried by ducts to the Dustube Collector where the dust is filtered out and reclaimed. This saves money as well as keeps the atmosphere clean throughout the shop area.

Consistently registering collection efficiencies of more than 99%, Dustube Collectors are the answer to dust and fume problems in mining and metallurgical operations. Special fabric tubes that withstand heat and corrosion enable this bag-type dust collector to provide similar efficiencies in smelting and sintering.

Wheelabrator Dustube Collectors used for these applications:

Electric Refining and Casting Furnaces
Crushing — Drying
Ice Handling and Storage
Dry Grinding and Classification
Loading and Packaging
Sintering — Calcining
Blast Furnaces
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For more information

To learn how Wheelabrator Dustube Collectors are able to recover valuable material, improve working conditions and better community relations, write today for a copy of the fully-illustrated, fact-packed, Catalog No. 372-C.

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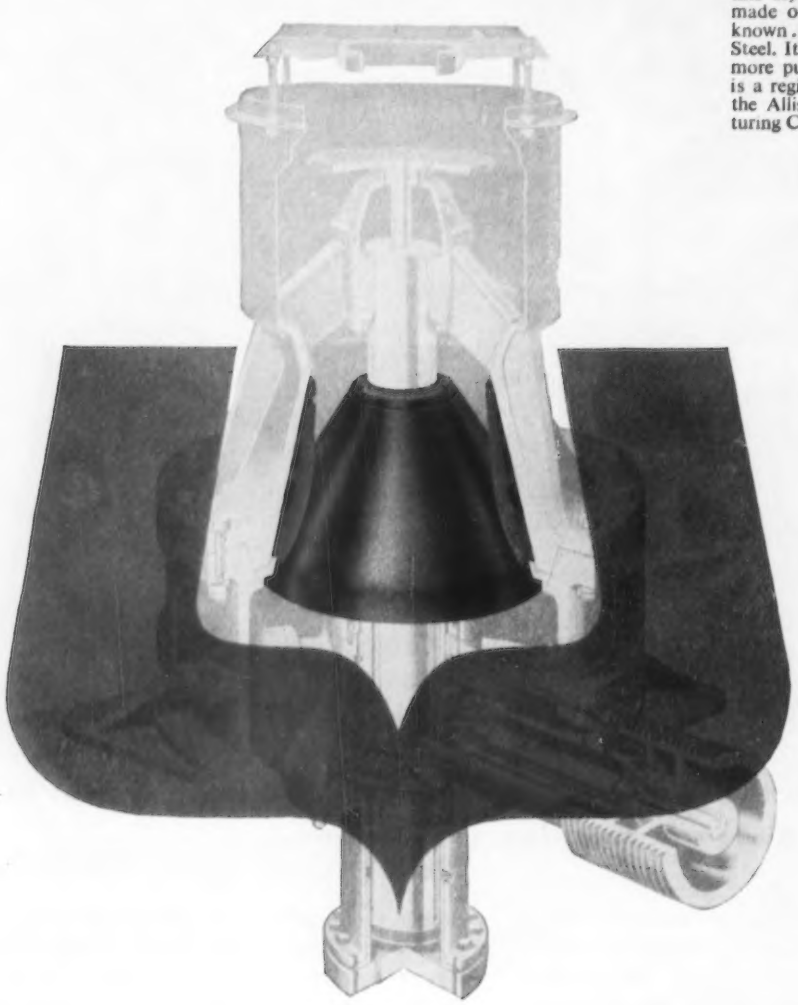

Concave ring and mantle of this *Hydrocone* crusher are made of the toughest steel known . . . Amsco Manganese Steel. It *gives* a little, to take more punishment. *Hydrocone* is a registered trade-mark of the Allis-Chalmers Manufacturing Company.

How a little give adds a lot of life to AMSCO CRUSHER PARTS

Both mantle and concave ring crush a lot more feed because of certain properties of Amsco® Manganese Steel. The metal *gives* a little under crushing forces, absorbs stresses, resists cracking and chipping. Yet these same forces work-harden the surface of Amsco Manganese Steel to as much as 500 Brinell . . . a high hardness, stubborn to wear.

Amsco Manganese Steel Crusher Parts maintain their ductile undersurface and work-hardened surface even when worn thin. That's why Amsco parts endure severe abuse for so many work hours without letup.

To be sure of getting Amsco Manganese Steel, order replacement parts from your crusher manufacturer. Amsco makes manganese steel parts for most manufacturers of crushing, grinding and pulverizing equipment.

Amsco also produces other alloy steels with maximum wear resistance under particular service conditions

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division · Chicago Heights, Ill.

OTHER PLANTS IN: DENVER, LOS ANGELES, NEW CASTLE, DEL., OAKLAND, CAL., ST. LOUIS, JOLIETTE, QUEBEC

Wyoming (*Continued*)

the firm will invest another $5-million in the facility.

Lucky Mc has sought AEC approval to increase the capacity of its mill from 750 to 1375 tpd.

The firm's officials said the present plant is contemplated to cost about $10-million and if the expansion is approved, $15-million will be spent.

The new Lucky Mc proposal would indicate that reserves on Lucky Mc property range from 3½ to 4-million tons.

Fremont Minerals, which is seeking AEC authority to build a third uranium processing mill in central Wyoming, has opened an office in Riverton. Fremont is a subsidiary of Susquehanna Corp.

A. W. Runge, district representative, has been placed in charge of the Riverton office.

Runge said his company hopes to get a satisfactory agreement with the AEC in time to complete construction of the plant by next spring.

The purchase of additional property near the low grade iron ore deposits at South Pass, were to be sought by U. S. Steel Co. at a meeting in Lander in June.

U. S. Steel has had an option on one 160-acre placer claim for nearly a year and wishes to enlarge the area covered under its lease with Timba Bah Mining Co.

Timba Bah has 10 patented mining claims covering 1,600 acres in the area.

A subsidiary of U. S. Steel—Columbia-Geneva Steel—is testing the iron ore deposits to determine if their development is feasible.

The Timba Bah property is located just west of the steel company's property. Timba Bah was formed in 1910 and during the 1930s and 1940s dredged for gold.

Trans-State Mining Co., a recently formed Wyoming corporation, has begun strip mining on its copper deposits near Encampment.

Guy Noel, secretary, said the company has a vein 21 ft wide, more than a half mile long and a proven depth of 500 ft.

He said plans call for erection of a mill on the property to handle upward of 200 tpd to upgrade the ore for shipment.

The ore also carries gold valued up to $11.50 per ton, Noel said. The ore assays 4.9 to 21% copper and a recent sample sent to American Smelting & Refining Co. at Salt Lake City showed a net value of $33.33 per ton.

Noel said there are two more large veins that will be tackled later.

Trans-State also has a silver-lead deposit that is to be mined beginning in late June or July. He said this deposit is 125 to 250 ft wide and four miles long.

IN CANADA

ONTARIO

Shield Development Co., a Noranda Mines—Anglo-Huronian company, has taken over management control of Coldstream Copper Mines. Latter company is preparing for production at its copper property in the Shebandowan area early this summer. Shield holds ground adjoining and down dip from the Coldstream ore zone.

Algoma Ore Properties is preparing its Sir James iron mine at Siderite Hill in the Michipicoten iron range for production. New mine will add some 500,000 tons of sinter to present production of 1.5-million tons. Diamond drilling at Siderite Hill has indicated about 80-million tons of ore to depth of 3,000 ft. Of this total 10-million can be extracted by open pit. Plant facilities to handle the additional tonnage are now being installed.

New Dickenson Mines has started a crosscut on its 15 or 2165-ft level to explore the adjoining property of Robin Red Lake Mines. The drive is to go out 2,000 ft, following which a minimum of $50,000 is to be spent in exploration on the Robin property. The program is being done under agreement

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Model T-20 Magnetic Separator. A small machine for a quick evaluation.

Model T-25 Magnetic Separator. The ultimate laboratory equipment for results directly comparable with commercial models.

Laboratory Equipment for Accurately Evaluating the Feasibility of Magnetic Separation for Quality or Yield.

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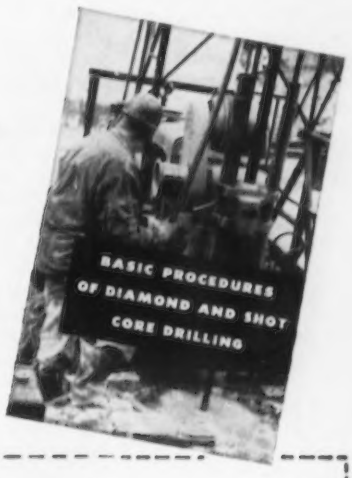

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At Warner Co.'s Cedar Hollow Quarry Big AUTOCARS Keep the Crusher Working to Capacity

Warner Co.'s Cedar Hollow Quarry, near Phoenixville, Pa., supplies better than 550,000 tons of stone a year. It's a big operation calling for big hauling equipment. On the haul from quarry face to crusher, Warner uses three Autocar units. Two are Autocar 6-wheel gasoline tractors pulling 17-ton-capacity side dump semitrailers. The other is a Diesel 10-wheel truck, with a 17-ton side dump body, pulling a 17-ton full trailer with side dump body. As the grade is only 4%, Warner hooks this additional 17-ton load onto the Autocar truck, hauls double the payload with only one power plant and one driver. Loads of 100,000 lb. are commonplace, and the three rigs are sufficient to keep the crusher at Cedar Hollow working to capacity.

The haul from crusher to stockpile is steeper—about 12%. Here two single-axle Autocars of 15-ton capacity, one with a diesel engine, one with a gasoline, operate on a fast trip cycle. Since they replaced three 10-ton trucks, they are effecting a considerable saving on the operation.

Warner Co.'s daily cost records supply convincing evidence that the extra power and stamina built into every Autocar is an investment in hauling economy. Whether it's a double payload or a single one with a quick turnaround, Autocars perform with outstanding dependability. The Warner fleet, now 2 years old, has required no major overhaul, only routine maintenance. The quality is there, applied with custom engineering. Get in touch with your White-Autocar distributor and find out how these great trucks can make your operation more profitable.

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Airborne Electromagnetic Detector, Plus Magnetometer and Scintillation Counter Now Deliver Correlated Data

Now an advanced new exploration tool—the electromagnetic detector, developed by Newmont Mining Corp. and AERO—is combined with the magnetometer and the scintillation counter for contract surveys by AERO anywhere in the world.

New detail and accuracy are obtained with these low level surveys. At tree-top height, the AERO helicopter follows contours closely over rugged or mountainous terrain.

Put AERO's million-plus miles of aerial exploration experience to work for you. Our engineers will be glad to discuss with you the application of the EM detector and other modern exploration tools.

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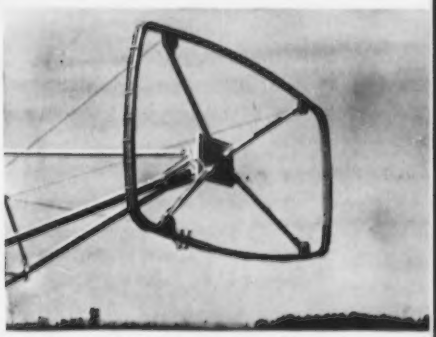
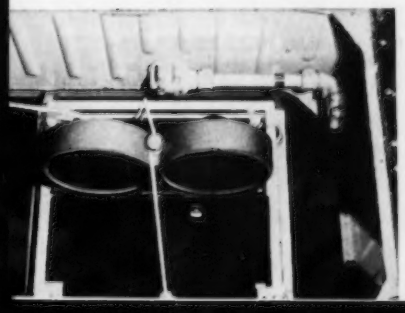


TARGET: LARGE SULPHIDE BODIES—EM coils fore and aft transmit tuned electrical signal. Response from conducting bodies such as ores of lead, copper and zinc is recorded as in-phase and out-of-phase components. ▲

MAGNETOMETER IN FIXED INSTALLATION—The magnetometer records signal from magnetic ore bodies such as iron, ilmenite and asbestos . . . also provides data which substantially aids interpretation of the EM record. ▼

WIDE ANGLE RECORD OF FLIGHT—Flight path of the helicopter is recorded continuously by strip camera with extreme wide angle lens, so path can be reconstructed exactly.

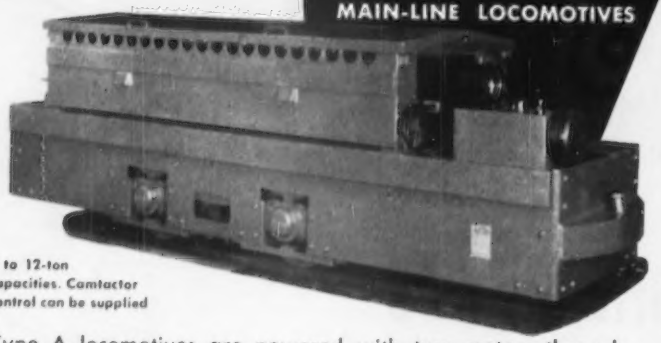


SINGLE RECORD CHART—5 TRACES—EM in-phase and out-of-phase signals, magnetometer and scintillation counter responses, and altitude are all recorded on a single, continuous chart for better correlation.

PROBE FOR RADIOACTIVE MINERALS—Scintillation counter, installed within the helicopter, records signal from uranium and other radioactive minerals on chart with EM and magnetic response.

LOW COST HAULAGE

ATLAS TYPE A
MAIN-LINE LOCOMOTIVES



3 to 12-ton capacities. Camtactor control can be supplied

Type A locomotives are powered with two motors through double reduction spur gear drives to each axle. You get full drawbar pull . . . extra payload. Investigate today the ton-mile economies awaiting you with Atlas locomotives.

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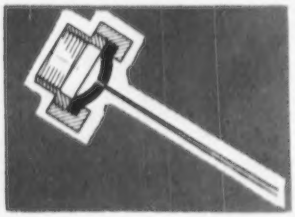

THE BOOTH NON-CLOG SPRAY

This is the only spray ever developed for flotation plants. The Booth Non-Clog spray can effect a reduction in plant launder spray water consumption of 40% to 60%. The durable rubber diaphragm automatically ejects any foreign material without flow interruption. Sprays are manufactured to fit standard 1" pipe. The orfice size may be quickly changed.

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— 40 YEARS OF ORE TREATMENT —

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Tell us what you have. Write:
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MICHIGAN CHEMICAL CORPORATION
Saint Louis, Michigan • or P.O. Box 481, Golden, Colorado

Ontario *(Continued)*

with Noranda Mines and Dome Mines, both of which have 25% interest in financing.

Good progress is being made in underground development at the Kenora area nickel-copper property of Norpax Oils & Mines. Development of the ore zone from the 375-ft, or second level, has been started. Drifting is continuing on the first level with the initial objective of opening up 1,000 ft of lengh nearly completed. Rate of advance will be stepped up on the second level as soon as this work is finished.

Greyhawk Uranium Mines expected to start ore shipments by July 1 from its Bancroft area uranium mine to the nearby Faraday mill. Initially, it is planned to ship at a rate of 250 tpd with the provision that this may be stepped up to 750 tpd after April 1. 1958. Estimated ore reserves are approximately 800,000 tons averaging 0.095% uranium oxide to vertical depth of 500 ft within a 2,000-ft length. Company has a letter of intent from Eldorado Mining & Refining for $20,350,-050 worth of uranium precipitates.

Arcadia Nickel Corp. is installing a 1,200-ton capacity mill at its Aer nickel property in the Sudbury area in preparation for production late this year. Negotiations for the sale of nickel concentrates or metal are now under way. Good progress is being made in underground development and in sinking the No. 2 shaft.

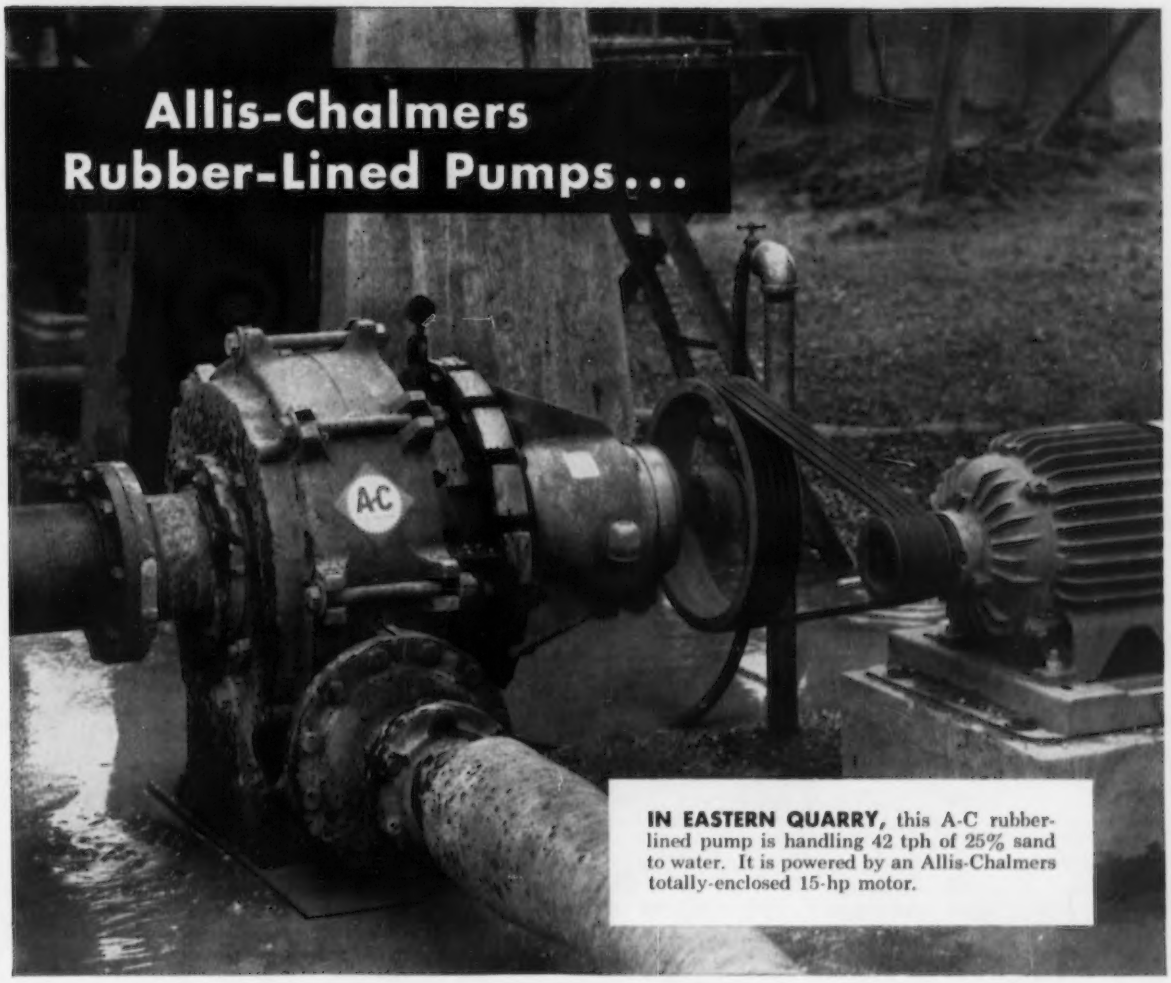
Operations have been suspended at the Mamainse area copper prospect of Coppercorp Ltd. Decision is based on the low copper price and tight money policy. It is planned to maintain the property in good standing until such time as conditions are more favorable.

Shaft sinking has been completed at the Nama Creek Mines lithium property in the Beardmore area. The shaft was put down to 500 ft and three levels were established. Over 4-million tons averaging better than 1% lithia were indicated in the preliminary diamond drilling program.

Consolidated Sudbury Basin Mines has contracted for sale of copper-lead concentrate from its mine in the Sudbury area to the American Smelting & Refining Co. Sale of zinc concentrate was arranged previously to Matthiessen and Hegeler of Illinois. Mill construction is continuing on schedule with the first 1,000-ton unit expected to start in August, this year. A second unit is to be added as soon as possible with the hope that capacity may be raised to 3,000 tpd in 1958. Reserves are estimated at over 17-million tons.

Caland Ore Co., Ltd., Steep Rock Lake, is aiming for total iron ore production of 3-million tons by 1969 under a three-phase operational program.

Plans were outlined by Philip D. Pearson, company manager, at the 71st annual meeting of the Engineering In-



IN EASTERN QUARRY, this A-C rubber-lined pump is handling 42 tph of 25% sand to water. It is powered by an Allis-Chalmers totally-enclosed 15-hp motor.

for long life with

Slimes and Slurries

If your pumping application requires handling of slimes, slurries, and other fine mesh abrasives, there's an Allis-Chalmers rubber-lined pump that's built for the job.

Here's a really tough pump designed to keep your pumping costs down, almost eliminate shut-down losses and even do away with standbys in many applications.

Rubber Lining of this A-C pump is bonded to a rugged steel skeleton which is simply fitted to the casing. When lining must be renewed, cartridge-type removal is easy — replacement takes minutes. The pump itself need not be moved.

Remember — Allis-Chalmers can supply the complete pumping unit of pump, motor, drive and control. Contact your nearby A-C district office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5331

IRON ORE sintering plant of Broken Hill Pty. Ltd., just recently completed at Port Kemla, New South Wales, Australia at a cost of $10.5-million, will help conserve Australia's iron ore resources and permit Broken Hill to get a better sinter.

Ontario *(Continued)*

stitute of Canada held June 12-14 at Banff, Alberta, in conjunction with a meeting of the Petroleum Division, American Society of Mechanical Engineers.

The company's target, said Pearson, "is to produce 750,000 tons of iron ore in 1960 and to develop mines to bring total production to 3-million tons by 1969."

QUEBEC

Consolidated Regcourt Mines is preparing to sink a shaft at its nickel-copper prospect at Kelly Lake in the Belleterre area. Plans call for shaft to 1,000 ft and the opening of five levels. Based on over 43,000 ft of diamond drilling, the company estimates indicated tonnage at 4.5-million tons averaging 1.45% combined nickel-copper to depth of 1,000 ft.

An orebody estimated to contain 4,668,000 tons has reportedly been indicated by diamond drilling on the adjoining properties of Yorcan Exploration and Campbell Chibougamau Mines in the Chibougamau area. Average grade is placed at 2.05% copper and 0.045 oz gold per ton. Of this estimate, 1,987,171 tons averaging 2.09% copper and 0.034 oz gold per ton is calculated to lie on the Yorcan side of the boundary. Tonnage on the Campbell side is given as 2,681,705 tons averaging 2.01% copper and 0.055 oz gold per ton.

New Formaque Mines is to carry out a test of a nickel prospect in the Lac Simon area, northwest of Montreal. Prospecting indicated a mineralized zone with widths of up to 400 ft. Preliminary sampling returned values in nickel, copper and cobalt.

A nickel find near Val D'Or, in the heart of northwestern Quebec's gold-mining belt, has touched off a prospecting rush.

Two veteran prospectors—John Manichulenko, and Vasile Melnik, reported the nickel discovery May 18 while working in Lamotte Township.

Columbian Mining Products, a subsidiary of Headway Red Lake Gold Mines and Coulee Lead & Zinc Mines, plans to install a pilot plant at its columbium property in the Oka area to test a new process. Extensive research has been carried out throughout the past year. Ore potential has been estimated at three cut-off grades: 106,503,345 tons grading 5.0 lb columbium pentoxide per ton, or 72,480,000 tons averaging 6.4 lb per ton, or 38,243,491 tons averaging 8 lb per ton. Depending on cut-off grade some 24- to 39-million tons could be mined readily by open pit.

Coniaurum Mines, a gold producer in the Porcupine area, Ont., is expanding its activities. It is to participate in the re-examination of a 10-claim copper prospect held by Ribago Rouyn Mines in the Rouyn area. The property has been idle for many years following extensive surface work, drilling, and exploration by shallow shaft. Deep drilling at that time picked up scattered copper mineralization. Present plans call for further drilling to test these indications.

Rexspar Uranium & Metal Mines Co. Ltd. has signed a contract with Eldorado Mining & Refining Ltd. whereby the latter has agreed to purchase $21,557,812 of uranium oxide for delivery between March 1, 1958 and March 31, 1963.

Eldorado also has taken an option to purchase an additional quantity up to $16.5-million worth for delivery between April 1, 1963 and Dec. 31, 1966.

NEWFOUNDLAND

Shaft sinking is expected to start by Sept. 1 on the Little Bay copper property of Atlantic Coast Copper Corp. A 3-compartment shaft to an initial depth of 1,000 ft is planned. Drilling has indicated some 2-million tons averaging 2.1% copper. Project is a joint undertaking of New Highridge Mining Co. and O'Brien Gold Mines, the latter having management control.

Newfoundland Fluorspar, a wholly-owned subsidiary of Aluminum Company of Canada, is planning to expand output from its Burin Peninsula mines by almost 50%. Production will be raised from 75,000 tons annually to 110,000. Enlargement of facilities is expected to be completed by year end.

NEW BRUNSWICK

Brunswick Mining & Smelting Corp. is going ahead with plans to bring its base metal property near Bathurst into production. The decision follows two years of pilot-plant testing and research. The initial unit will be a 2,000-ton flotation mill, plus a lead smelter and sulphuric acid plant. Provision has been made for subsequent addition of one or two more 2,000-ton units. Production is scheduled for spring, 1960.

Billiton Maatschappij of The Hague reports having acquired a more than 60% interest in the recently floated Nigadoo Mines Ltd. in New Brunswick in which important lead, silver, copper and zinc deposits have been found.

BRITISH COLUMBIA

Companies will carry out the greater part of their planned exploration programs in the province this year despite the recent provincial government mining legislation, the prospects for next year and after are clearly evident from replies of the major exploration companies to independent surveys now being made by promoters, mining engineers, prospectors and others vitally interested.

They state that the only cause they would have to resume their programs would be the removal of leasing tenure which replaced the Crown granting of mineral claims at the last session of the legislature.

Some aerial survey firms are already encountering hardening sales resistance.

The sales manager of Aero Surveys Ltd., Frank N. Buckley, after a canvass of many of the big exploration companies to offer a magnetometer service said:

"We doubt if we'll be doing any mining work in B.C. this year. Mining companies are definitely not interested and some reported they are curtailing their operations this year. As a result we're concentrating on work for oil companies."

A well known Canadian firm said exploration will be "seriously reduced" until such times as "the regulations for holdings in the ground are clarified."

A major American firm said "some projects now underway may not have taken place had this legislation been forseen."

A British mineral company says the "drastic changes" in the Mineral Act

A new O-B Cable Fault Locator!

(in a light-weight, rugged, "pocket-size" package)

Here's the simplest, lightest, most inexpensive, and easiest to use cable fault locator ever offered for mine service!

Designed to pinpoint both short and open circuits in trailing cables having two or more conductors — powerful enough to test cables up to 600 feet long! Complete "pocket-size" package consists of four small, extremely rugged elements which are shipped from the factory — and carried around the mine — in the handy canvas bag shown above.

To operate, simply connect battery and signal generator (about the size of a flashlight) to power end of cable and then move along cable with receiver and headphones as shown above.

Headphones and rugged, all-transistor receiver are only parts carried along cable!

Weighs under four pounds, costs less than any cable you'll use it on!

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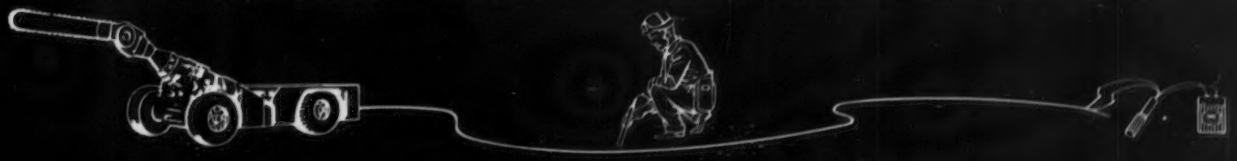

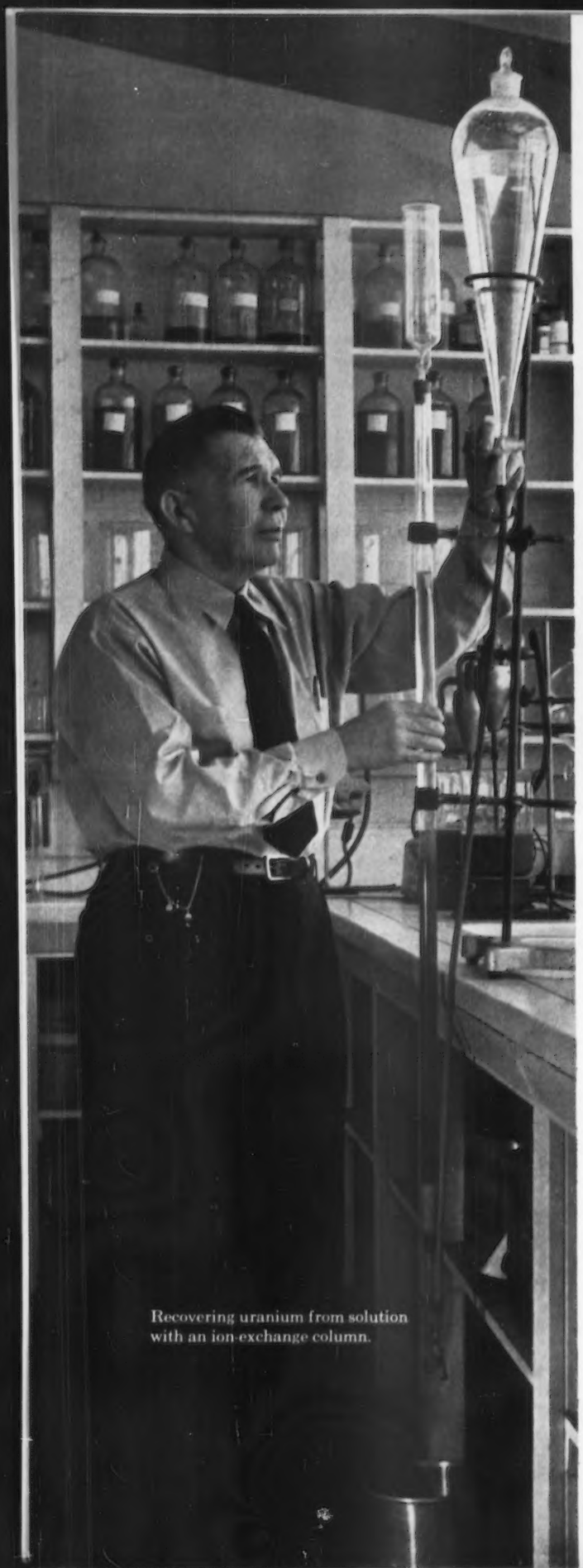

Recovering uranium from solution with an ion-exchange column.

SWECO's Ore Investigation Laboratory has studied 4,000 ore samples to determine feasibility of milling on a commercial basis.

To Mill... Or Not To Mill?

"Should I build a mill to treat my ore commercially? How can I find out – without going to the expense of full-scale production?"

Laboratory-scale investigation

SWECO's Ore Investigation Laboratory has successfully answered these questions 4,000 times over – for operating companies in the mineral processing field, for investment groups and financial institutions.

Again and again, thorough laboratory investigation has minimized or completely avoided expensive testing on a plant scale. And the scores of mills designed on the basis of SWECO Laboratory findings are profitably proving that laboratory results can be duplicated in commercial operation.

Supplemental or complete service

Available on a custom basis at the SWECO Laboratory is an expert team of metallurgists and ore investigation technicians, pooling years of field, laboratory and design experience. Here is a complete facility for every phase of ore investigation: visual inspection, sample preparation, analysis, study of the most up-to-date ore concentration methods. SWECO's Engineering and Construction Division is staffed and equipped to undertake all or any part of your ore beneficiation program, from laboratory investigation through flow sheet development, feasibility report, to design and construction of the mill itself.

SWECO has a world-wide reputation for dependability and service . . . in *engineering and construction* . . . in the *design and manufacture of specialized process equipment* . . . in a complete line of superior *vibrating screen separators.*

For complete information on SWECO ore investigation services, write for bulletin E-6-12.

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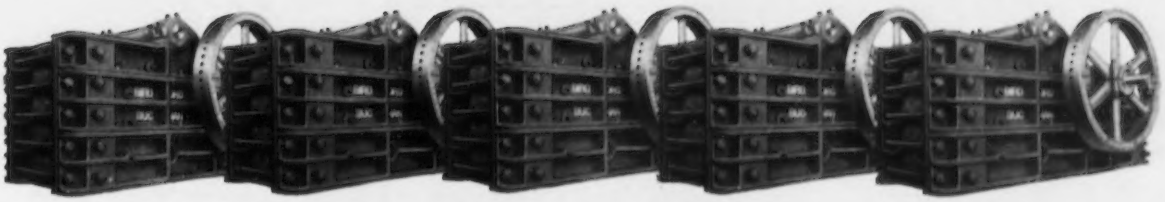
African Copper Mine Uses 5

BIRDSBORO Buchanan

Crushers Underground



Battery of 36" x 48" Crushers Used for Reduction of Copper Ore

• Birdsboro-Buchanan's special sectionalized frame design permits easy lowering into the restricted area of the shaft at this South African copper mine. And Birdsboro engineers designed these units for highest possible production of copper ore. Their success is proven by the repeat orders received. Service like this is typical of the "customized" design you get through Birdsboro-Buchanan. For better handling of standard crushing problems and specialized handling of unique crushing problems . . . seek the answers through your Birdsboro representative. Call him now or write to Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. *District Office:* Pittsburgh, Pa., *Subsidiary:* Engineering Supervision Co., 120 W. 42nd St., New York 36, N.Y.

World Wide Agent Representation. Contact home office for nearest representative. *Canadian Representative:* John Inglis Co., Ltd., Toronto, Canada.

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B.C. *(Continued)*

make further exploration "unattractive."

A uranium prospecting firm reports "we are materially deceasing our program in B.C. until we are sure of the rights of miners and prospectors under the new laws."

Another U.S. exploration firm says "we plan to carry out most of our work this year, but we expect a substantial decrease in our budget for B.C. in 1958."

Phelps Dodge Corp. is to prospect and explore a 1,000-claim property held by Jericho Mines Ltd. in the Highland Valley.

If it is decided to go into production under a five-year agreement a new company, Anson Mines Ltd., will be formed.

Jericho claims surround on three sides the Bethlehem Copper Corp. Ltd., property which is being developed by American Smelting & Refining Co.

American Smelting & Refining Co. will expand its exploration program on the Highland Valley Bethlehem property.

Schedule of expenditures from May 1 to October 1 is to be $60,000 a month.

Expanded exploration program will attempt to add to reserves, increase tonnage and improve average grade.

Trojan Consolidated Mines Ltd. feels its present program will prove up a big copper orebody of profitable grade, warranting installation of a 2,000-ton mill.

Two major U.S. copper producers have examined the drill cores at Trojan and have expressed a definite interest in participation of future development and milling.

A decision will be finalized as soon as sufficient work has been done to allow examination of underground conditions.

The ore would be mined by open-pit method.

Exploration is progressing and every fourth car of ore is being put through the sampling crusher to provide samples for assaying.

At last report the shaft had been extended 10 ft below the 150-ft depth in order to provide a temporary sump. Blasting for the station and first level at the 150-ft horizon has started.

At a depth of 145 ft in the shaft, large fractures containing massive copper sulphides and carbonates were encountered and a sample assayed at 8.25% copper.

Reeves MacDonald Mines, Ltd., of Remac, has begun shaft deepening operations at its zinc-lead property, Jens Jensen, president, said. The shaft will be extended about 1500 ft and will increase the vertical depth of the mining operation about 600 ft.

Jensen said that each 100 ft of depth added so far has meant an additional 100,000 tons of ore reserves. About 1.5-million tons of ore have been extracted from the mine since 1950. Current production is running about 1150 tpd. All concentrates are being shipped to Bunker Hill Co. at Kellogg, Idaho.

New Taku Ltd. is negotiating with Consolidated Mining & Smelting Co. Ltd. for the latter to explore and develop a group of about 20 claims owned by New Taku on the east bank of the Tulsequah River in the Atlin area. New Taku will receive a fixed annual royalty payment plus an additional tonnage payment of about 35c per ton.

Northern Gem Mining Corp. with a cobalt property in the Bridge River district about 100 miles north of Vancouver, has started a $140,000 work program, drilling from three levels, with about 7,000 ft of drilling to complete this phase of the program.

Geological and geophysical surveying will be done over the property and arrangements will be made for suitable ore storage.

Cowichan Copper Co. Ltd., expects to have its recently purchased mill on Vancouver Island operating by November, following proving of enough ore for three years production with minimum annual production of 6,000 tons copper.

It is planned to increase exploration and development as the company approaches the end of the first three-year period.

Initial average grade for mill feed will be 5%, and maintenance of the announced quota will be assured by increasing the mill capacity as the grade is reduced to 2% copper. The transition from 5% to 2% grade with correspond-

get more earning power with...

Greensburg storage battery locomotives

5 TON HIGH TYPE MONITOR

Available in 3 to 12 tons: 42 to 48" high, 18 to 56½" track gauges.

Greensburg's dependable performance results in operating economy. Advanced engineering design and custom-building to specifications give Greensburg Locomotives up to 20% more efficiency and longer battery life than any other storage battery locomotive of equal weight and battery capacity. More earning power per dollar invested!

Built in single or double motor drives with double equalizers, drum or contactor type controllers, with or without dynamic braking, Greensburg Locomotives will haul more and cost less to operate!

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CORE DRILLING Anywhere

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through
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Between now and this time tomorrow — in 27 U. S. states and in 24 of the principal mining countries throughout the world — Wemco Fagergren Flotation Machines will process well over a million tons of ores. The combined feed, including all the principal metallics and non-metallics from Antimony to Zinc, would equal the cubic content of a 100′ x 100′ building 72 stories high!
Whether the tonnage you process is large or small, you'll be interested in getting the facts that back up the industry-wide preference for Wemco Fagergrens . . . now in use in individual installations of from one to over 700 cells. Write today, or call in your Wemco representative.
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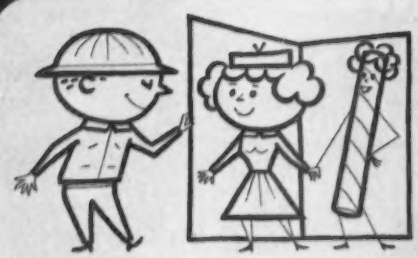
"How to handle WOMEN and EXPLOSIVES"



TREAT THEM GENTLY AND WITH RESPECT

PROTECT THEM FROM UNAUTHORIZED PERSONS

OBEY THE DO'S AND DON'TS

to help you blast with greater safety

You'll protect your safety record and gain a smoother, safer blasting operation if you use the new Atlas movie "*How to Handle Women and Explosives*" to help your men observe basic safe practices in their work.

You'll make a deep impression at your next safety meeting with this film which is calculated to bring out amused chuckles and possibly a few guffaws. At the same time it stresses the fact that both women and explosives must be "handled with care" and that both have a list of Do's and Don'ts which must be observed in order to get along with them safely.

Many large operations are using "*How to Handle Women and Explosives*" as a safety meeting kick-off and following with a discussion of the Do's and Don'ts case insert.

The film, complete with a suggested program kit and enough copies of the Do's and Don'ts for your audience, will be sent to you without cost if you write us on your company letterhead, giving the date or dates you plan to use it.

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No Guesswork When Laboratory Crushing or Grinding is Done by Sturtevant Machines

"Open-Door" Design Provides Quick Access for Cleanout — Guarantees Accurate Samples

Sturtevant Automatic Coal Sampler at Con Edison's Laboratory (New York). Sturtevant Bulletin No. 85 describes this machine.

In a matter of seconds, because of hinged access doors, all crushing or grinding parts are exposed for thorough cleanouts — 100% accuracy in sampling.

Design of Sturtevant laboratory machines is based on production models. Higher output — to scale with actual production quality and output, is built into each machine. Add rugged construction and you have a machine that keeps on top of lab or pilot work.

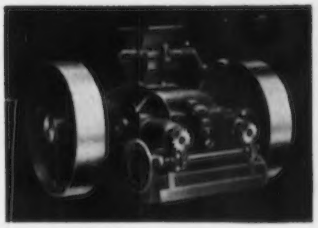
Preferred by laboratories that demand accuracy and dependability in test or pilot runs, Sturtevant laboratory machines have long been used by the 'blue chips' of industry and education. Names on request.

Send for Bulletin 067, which gives full description of all Sturtevant laboratory machines. (Bulletins are also available on Production Crushers, Grinders, Blenders, Air Separators, Micronizers and Automatic Coal Sampler.) Write Sturtevant Mill Company, 101 Clayton St., Boston 22, Mass.

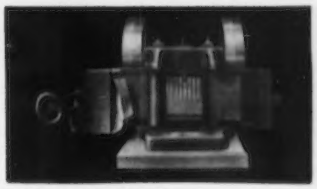
SWING-SLEDGE MILL RETIRES AFTER 25 YEARS . . .

Ruggedness of Sturtevant machinery is well-known in industry, where even laboratory-size Sturtevant units are sometimes used for round-the-clock production.

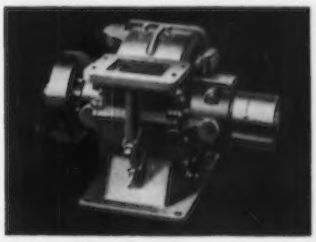
Jas. F. Morse Co., Boston, recently replaced their small-size Swing-Sledge Mill, which had been doing production grinding for 25 years. It was used to grind ⅝ in. tankage into bone meal. Repairs in 25 years? "Just grates and hammers," reports Plant Manager W. Carleton Merrill.



Lab Crushing Rolls: Specially designed for laboratory sampling, Crushing Rolls come in two sizes: 8 x 5 in. and 12 x 12 in. Capacities run as high as 10 tons per hour. Automatic adjustments: 8 x 5 in. model adjusts from ½ in. to 20 mesh; 12 x 12 in. model from ¾ in. to 20 mesh. Tires are high carbon forgings and extra tough. Feeder is automatic, adjustable.



Lab Jaw Crusher: Full or part-time duty for crushing hardest rocks: 2 x 6 in. opening Jaw Crushers have roll jaw action — no clogging. Hard rock capacities: ½ in. setting — 1900 pounds per hour; ¼ in. setting — 1200 pounds per hour; ⅛ in. setting — 800 pounds per hour. Instant in-operation adjustment. Jaw Crushers have manganese steel jaw plates, reversible shields, steel pitman, antifriction bearings.



Lab Swing-Sledge Mill: 5 x 6 in. feed opening takes soft, medium, tough or fibrous material. Capacity to 1 ton per hour, fines regulated from 1 in. to 20 mesh. Single-pass limestone grinding produces 99.8% 10 mesh fines, 95.8% 20 mesh. Single-pass bituminous coal pulverizing gives 99.9% 10 mesh fines, 91% 20 mesh. Choice of gratings, hammers (or knives).

Sample Grinder: Disc type grinders for dry, friable, soft or medium materials. Three sizes — 6 in., 10 in. and 14 in. take feed as coarse as ¼ in. 100 mesh fines at rates to 200 pounds per hour on largest model. Product regulates from 10 to 100 mesh. In-operation adjustment.

STURTEVANT

Dry Processing Equipment

The "OPEN-DOOR" to *lower* operating costs over *more* years

CRUSHERS • GRINDERS • MICRON-GRINDERS • SEPARATORS
BLENDERS • GRANULATORS • CONVEYORS • ELEVATORS

B.C. (*Continued*)

ing increase in mill capacity is planned to cover the three-year period.

J. R. Billingsley has been appointed mine manager. He will assume responsibility of preparing for production and then directing operations as resident manager.

MANITOBA

Chipman Lake Mines reports three drill holes have been completed in the preliminary investigation of its property near Moak Lake. Results are being used to interpret geophysical data. Minor sulphide mineralization has been encountered. Further drilling has been planned to cross-section a high EM anomaly.

Sherritt Gordon Mines reports a new orebody was encountered at Lynn Lake during 1956 between the 'A' and 'E' orebodies. It was found to apex near the 14 level and has been drilled to 500 ft below this level. Indications are that the ore zone may be similar in size and grade to the 'E' orebody which extends from surface to the 12 level.

Hudson Bay Mining & Smelting plans to start underground development at two of its Snow Lake properties this summer. At Chisel Lake the hoist has been taken in and the headframe is being completed. Nearly 4-million tons running better than 11% zinc has been indicated on this property. At Still Lake the shaft has been collared and shaft sinking will commence later in the year. It is expected both properties will be in production by 1960.

SASKATCHEWAN

International Minerals & Chemical Corp. announced that it will start immediately sinking a shaft for a new potash mine in Saskatchewan. The site is on 450,000 acres which International controls under permits near Esterhazy, 150 miles east of Regina.

Contract for construction of the mine shaft and several surface structures has been let to Utah Construction Co. of San Francisco with work to begin immediately.

IN LATIN AMERICA

CHILE

La Africana 700 tpd flotation mill is to go on stream about mid-July. Anaconda developed La Africana and Lo Aguirre mines which are situated some 30 miles west from Santiago in the twenties but let these two properties stand idle until the passing of the new copper tax law made exploitation possible. La Africana has 3-million tons of 3% sulphide ore while Lo Aguirre has 10-million tons of 2% mixed ore which presents a far more difficult beneficiation problem than La Africana, a straight flotation proposition.

During the first quarter of the present year Paipote copper smelter produced 5,221 short tons of blister which contained besides 5,920 oz gold and 52,200 oz silver. Blister has been shipped to the Norddeutsche Affinarie at Hamburg for refining. Since the Paipote smelter was fired in 1952 the whole of its blister has been refined at the N.A. at Hamburg under contract which was recently renewed for another two years.

Some difficulties have arisen with regard to the location of the new copper smelter and electrolytical refinery which Empresa Nacional de Fundiciones will build to smelt the output of copper ores and concentrates from Central Chile. Favored location is Papudo, a small port north of Valparaiso. So far, the Board of Empresa Nacional de Fundiciones has not chosen which of the three large industrial combines, American and German, which bid for the machinery, will get the order.

Compania Minera Disputada de Las Condes, a Chilean company controlled by French mining interests, which has been treating its low grade copper ores since 1927 at a mill located 35 miles east from Santiago, plans to increase its capacity from 700 to 3,000 tpd. This increase in capacity will need a large investment because the mine is located at a difficult terrain at the Andes mountains at 13,000 ft altitude. A new ropeway, new hydroelectric plants, camps, etc. will be required besides increasing machinery both at the mine and at the mill.

To exploit the few uranium deposits so far found in Chile a fiscal corporation will be formed by three government agencies, the Mining Credit Bank, the Chilean RFC and the Smelters Corporation. In Chile, uranium ores are closely associated with copper deposits. So far as known uranium ore has been found at Carrizal Alto, Las Animas, Los Azules, Pampa Larga, Cabeza de Vaca and Romeral. Grade varies between 0.2 and 0.3%

PERU

G. A. Runge, Montreal, Canada, mining engineer is now visiting Lima in connection with the closing of a three-year option on the famous Santo Domingo gold mine in the Inambari valley, southeastern Peru. Property is now owned by the Inca Mining & Development Co., of which Clarence Lee Woods is the principal shareholder. The name of the new mine operating company is Cia. Minera Sandia-Carabaya, S.A. The mine is reached by a 100-mile motor road from Tirapata, on the Southern Railways of Peru, to a point known as Agualani, and thence by a 30-mile mule trail. Worked for more than half a century by a succession of owners, the mine has made several fortunes, but operation has been handicapped by the irregularity of the deposits and the distance from a base of supplies.

VENEZUELA

The official estimate of Venezuela's iron ore reserves has nearly doubled.

Annual report for 1956 of the Ministry of Mines & Hydrocarbons, submitted to Congress recently, sets total proven and probable reserves at 3,783,000,000 metric tons. This compares with a figure of 1,955,000,000 metric tons in the previous annual report.

Principal increase is in the estimate of probable tonnage on national reserve acreage, now set at 2,384,000,000 metric tons as compared with 600-million metric tons a year ago. Upward revision of the estimate is the result of exploration on reserves adjacent to workings of U.S. Steel and Bethlehem Steel in Bolivar state.

The breakdown of reserves: (millions of metric tons)

Private concessions	
Proven (58-68% Fe)	597,
Proven (35-45% Fe)	125,
Probable	350,
National reserves	
Recognized	327,
Probable	2,384,

MEXICO

A Mexican Treasury official says that the cancellation of the iron deposit concession which Colorado Fuel & Iron Co. was developing in cooperation with Mexican capital will remain in force.

In mid-May President Adolfo Rutz Cortines cancelled the concession for the Peña Colorado concession on which Cia. Impulsora de Industrias Basicas says that 150-million metric tons of iron ore have been proven. The deposit was being developed by Industrias Basicas, CF&I and the Mexican government through Nacional Financiera. Also, the French bank, Credit Lyonnaise de Paris, had extended a credit of about $23-million.

The Peña Colorado concession is located in the West Coast State of Colima, 35 airmiles north of Manzanillo, a principal seaport. Development plans included construction of a 1,000 tpd steel mill in Manzanillo.

Shortly after the cancellation, Industrias Basicas took legal action which it claims suspended the cancellation until the matter is finally settled. Government says that it plans to enforce the cancellation, that it is not now suspended as Industrias Basicas claims.

At the time of the cancellation, the Mexican government said that Industrias Basicas, in which CF&I holds a 30-40% interest, would be reimbursed for all moneys spent developing the iron deposit. Repeatedly, the Mexican

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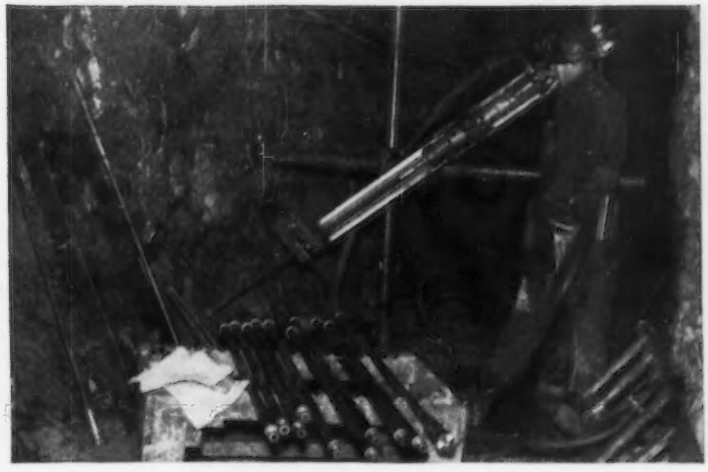

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- ☐ Drill Steel Forges
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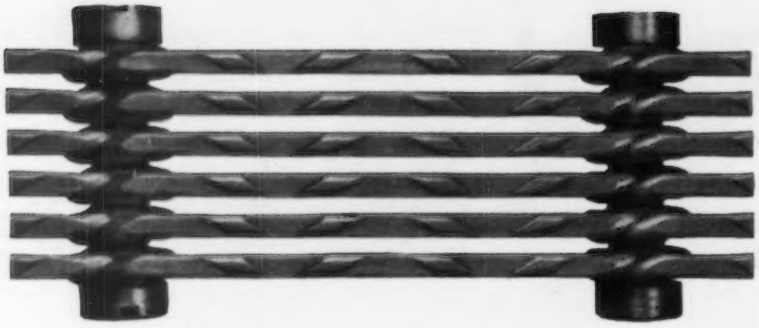

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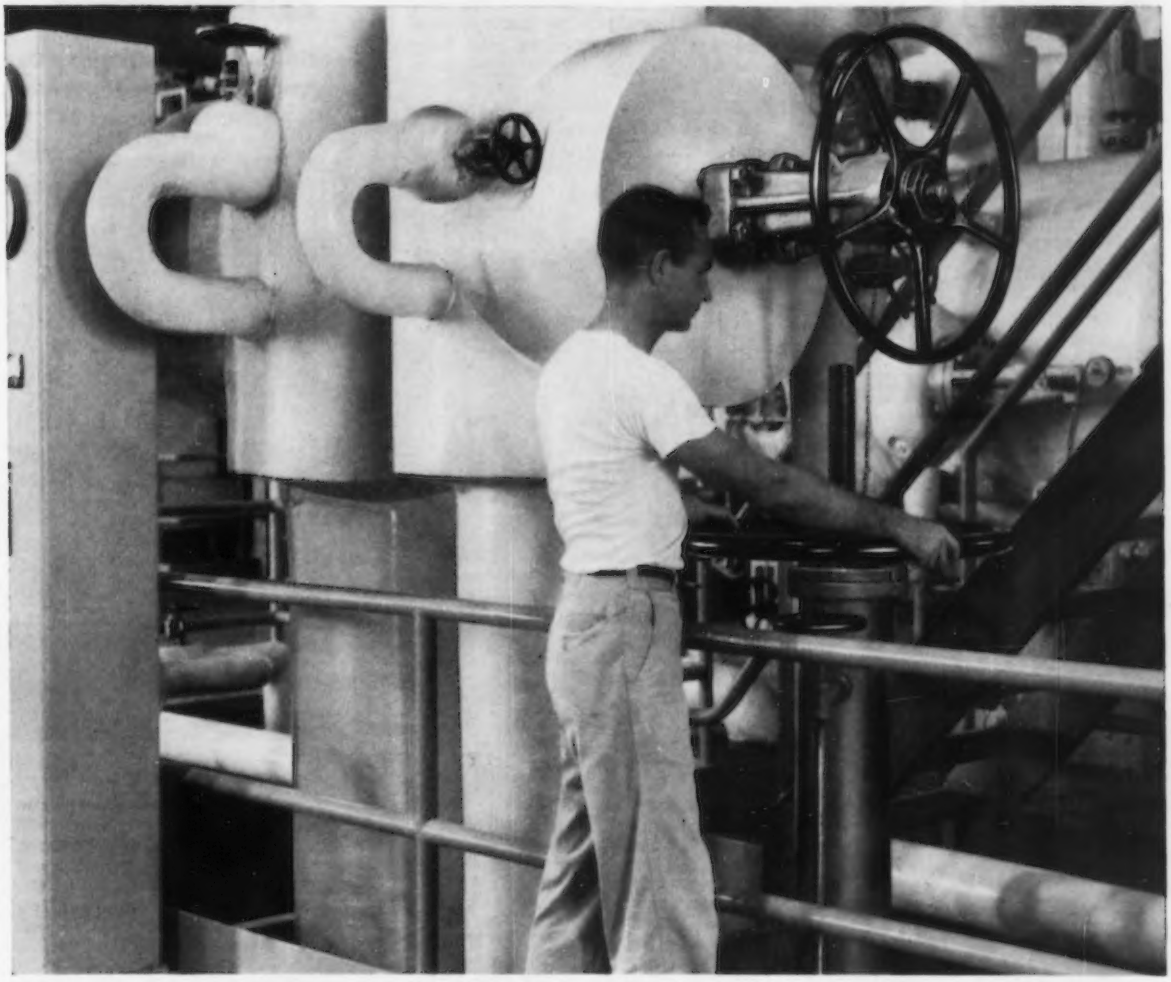
The Buyers' Guide Section in E&MJ's Mid-June, 1957, Mining Guidebook out last month is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufaturers serving the field—a company-by-company check conducted by the E&MJ editors just for this 1957 edition. Manufacturers advertising in this issue appear in bold-faced type in the Buyers Guide. You'll find more helpful product information in their advertisements.

E&MJ's MID-JUNE MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all E&MJ subscribers.

How Crane Steel Valves Cut Power Piping Costs



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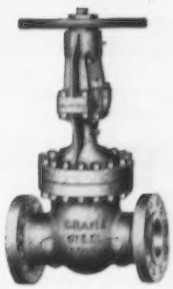

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Mexico *(Continued)*

government emphasized that CF&I acted honorably throughout the whole proceeding and that the Mexican government continues to enjoy friendly relationships with CF&I.

President of Industrias Basicas is Manuel Garcia López, who was a cabinet minister of former Mexican President Miguel Alemán.

The final outcome is still clouded. Industrias Basicas says that it has done nothing wrong and it is going ahead with plans. And the government says that if they do, they will do so without a right to the iron mining concession. Actual mining was to have begun in December.

IN THE PHILIPPINES

At the end of the first quarter of this year Benguet Consolidated reported an unusually strong financial position, with cash and bullion totalling nearly $2.9-million, total current assets over $7½-million, while current liabilities were less than $700,000. Operating income for the quarter was $1.6-million from gold bullion produced, a substantial increase over 1956. Operating profit was over $72,000, in contrast with a loss of $147,000 a year earlier. An even better showing was made by Benguet's subsidiary, Balatoc, which had a 10-fold gain in profits for the first quarter of the year over 1956.

New chromite producer, Liberty Chromite Mining Corp., will start shipments to Japan from its property in Puerto Princesa, Palawan.

Largest producer among the base metal mines in April was Consolidated Mines, with shipments of 52,820 tons of refractory-grade chromite ore valued at $1,019,000. This was followed by Atlas Consolidated with value of its copper production at ú860,000.

Atlas Consolidated milled 247,786 tons in April grading 0.67% copper. Concentrates averaged 22.6% copper. Total copper output was 2,904,197 lb. In addition the company shipped 17,090 metric tons of iron ore from its Mati mine.

Palawan Quicksilver Mines will install a third kiln at its property. Reserves total 23,158 flasks of mercury, valued at over $5.9-million sufficient for 5 years' operation at the increased rate of production.

Marinduque Iron Mines started its $5-million copper mill early in May at the Sipalay project on Negros Occidental. The new mill can treat 4,000 tpd. Production is expected to exceed 10,000 tons of copper annually.

At its Cabaya Lease in Sambales the operating company Mindanao Mother Lode has increased ore reserves to 228,600 tons of 3% copper. Production in 1956 totalled 3,320,000 lb copper. However, operating costs average about 30c a lb before depletion and on the present copper market operations are showing a loss. John C. Curtis is general superintendent.

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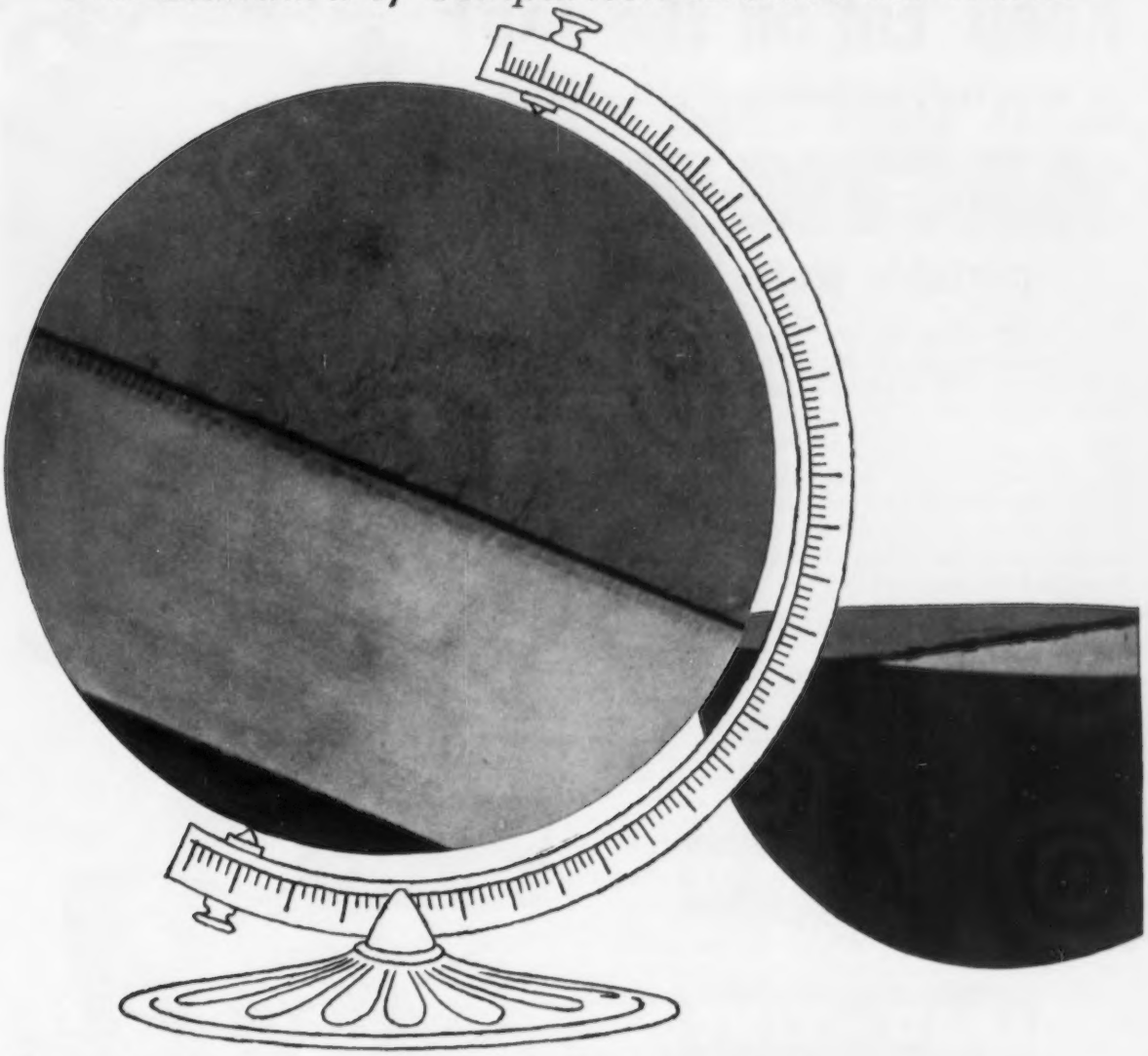
IN AFRICA

A new vanadium mill in the Transvaal, South Africa, with an output of 3.6-million lb of concentrate annually, will come into production in September, president Blair Burwell of Minerals Engineering, Grand Junction, Colo., has announced.

Burwell said the mill is a venture in which Rockefeller Center, Inc., and High Speed Steel Alloys, Ltd., of England have joined with Minerals Engineering. Company has been named Minerals Engineering Co. South Africa.

The Standard of Comparison Around the World



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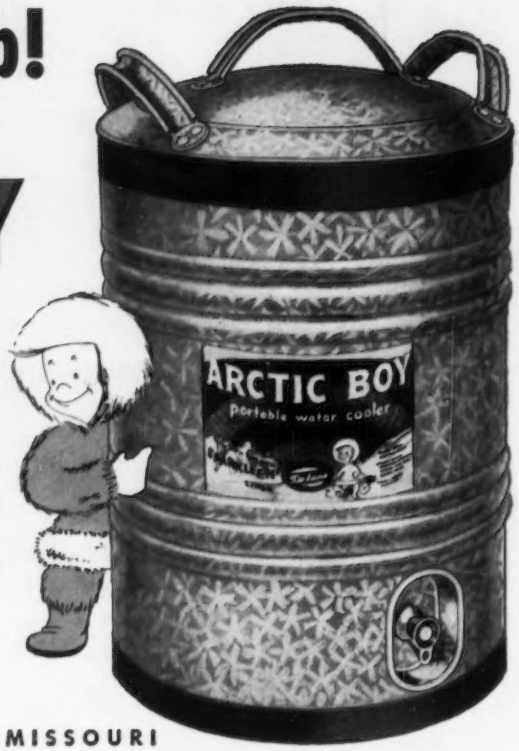

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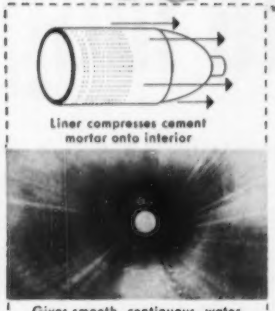

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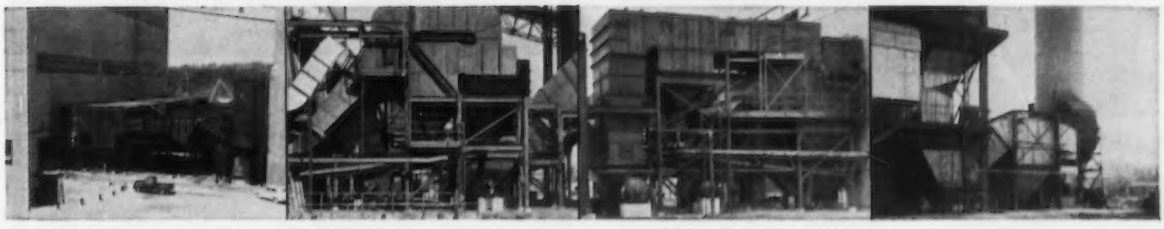

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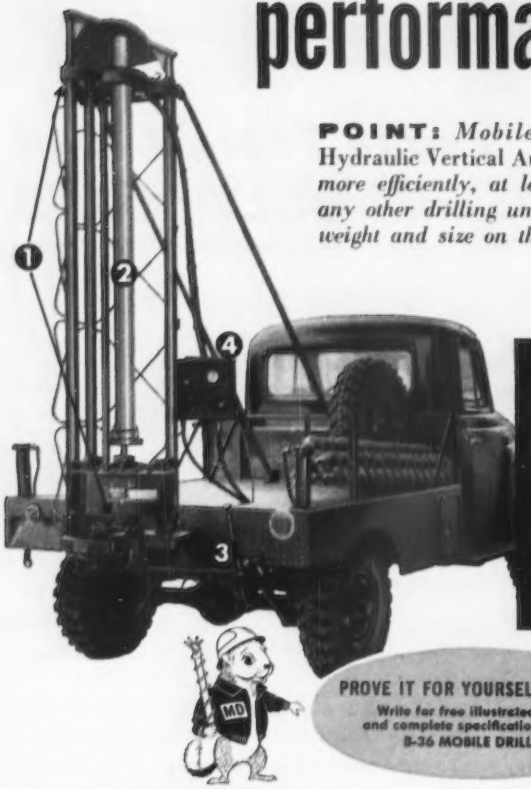

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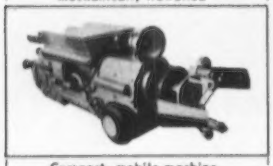

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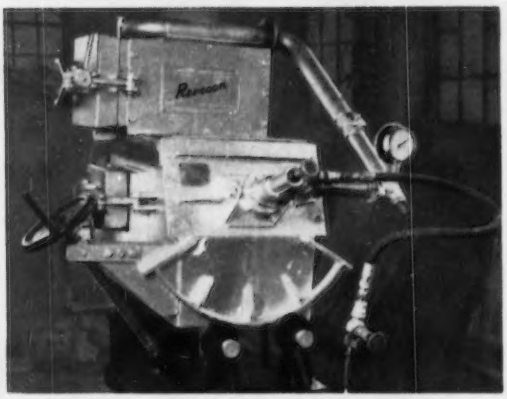

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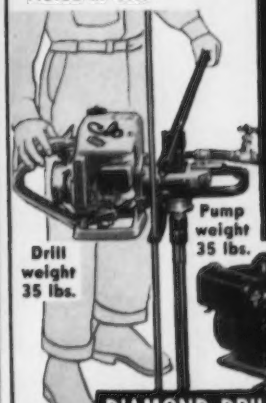

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Franks and beans were the supper menu for Al Knoerr and Phil Simmons, of the Atomic Energy Commission, when they ate off a jeep tailgate on the Colorado Plateau. Inset (above) shows one result: Al accepting the Jesse H. Neal Award.

Mileage, Mines and Millionaires

Alvin Knoerr, Editor of **Engineering & Mining Journal**, *Covers Two Continents to Help Produce Award-Winning Articles*

BACK IN '54, Alvin W. Knoerr was planning a special story for *Engineering & Mining Journal*, the magazine he edits. He knew the uranium mining boom was the biggest thing in mining history . . . dwarfing the Klondike gold rush in importance . . . and had run a continuing series of feature articles on uranium, beginning in 1945.

Al and George Lutjen, his managing editor, made a two-week field trip . . . lived out of a jeep while covering 2,000 miles of the 4-state Colorado Plateau. They stopped at all the richest working mines, interviewed AEC people. They talked with millionaires like Floyd Odlum and Charlie Steen (who got into uranium originally as a result of an earlier Knoerr article, "Can Uranium Pay?"), and with hard-bitten prospectors still looking for their first strike.

First result of the trip was an article "U_3O_8 . . . Formula for Profits," published in September '54. Since then, some 18,000 reprints have been distributed. And the article received two major awards for business magazine editorial accomplishment*—only time this has happened to any business magazine.

If you ask Al Knoerr what a business magazine editor's job is, he'll tell you it is to see the opportunities lying ahead for his industry, and then to "take the industry by the hand and lead it." An editor never knows where these opportunities may lie, which is why Al travels up to 20,000 miles each year. He's been through Brazilian jungles and high up into the Andes as he covered practically every mining area in two continents.

What kind of a man is Al? He learned mining the hard way—summer work as a chute blaster and high hang-up man, timberman and mucker. His theory comes from Wisconsin Tech, Missouri School of Mines, and a degree "with the highest honors" as a mining engineer. For two years after his graduation, Al taught at Wisconsin Institute of Technology, then joined McGraw-Hill. From Assistant Editor of E&MJ, he progressed to Associate and then his present job as Editor. Al shares full credit for the position of his magazine in its field with the rest of his staff.

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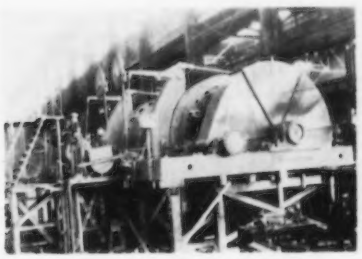

900 HP Allis Chalmers Hoist

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140—10 Ton Capacity Rotary Dump, 30" ga.
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EXCELLENT ! !

800 HP Nordberg Hoist

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1—Mitchell Diamond Drill air motor, underground for Ex. Rod.
1—Chicago Pneumatic #55 with air cylinder

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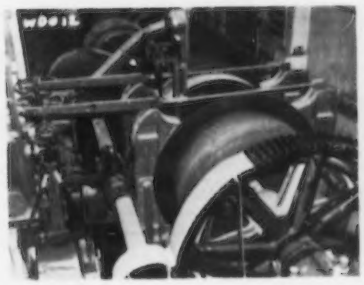

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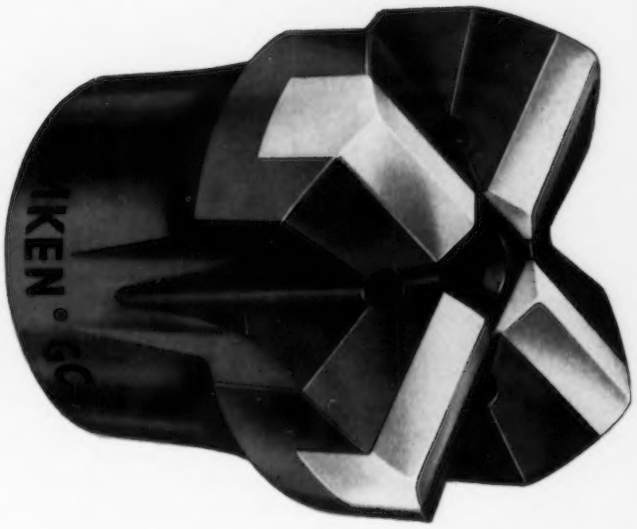

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